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THE WRECK OF THE KEARSARGE.

A NARRATIVE.

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A cable reached the Admiral on Tuesday, January 30, 1894, to proceed to Bluefields, Nicaragua, and next morning we were off Navassa, where we picked up a good trade breeze from ESE., made all sail and hauled to the southward to clear Morant Cay, a very dangerous reef in that locality; only two of the four boilers were in use, and the fires were banked under those after the ship was well clear of Morant.

The weather was fair and remained so throughout the trip, heavy trade clouds passing over continually bringing along light drizzles of rain at night. The breeze was stiff to fresh from ESE. to ENE., averaging about E. by N., with the usual, short, hollow trade sea, which fitted the ship's period so well as to cause an easy roll of about sixteen degrees when the fore-and-aft sail was not drawing.

At 8 P. M. on Thursday, February 1, a point twenty miles south of the southern extremity of Roncador reef bore SW¼W., distant 180 miles, and the course was set to make an allowance of two points to the southward for leeway and current, the latter estimated at 1¼ knots, setting due west but expected to set more to the northward during the night.

The 8 A. M. sight of Friday morning, February 2, confirmed the expected set to the westward, but indicated a very much greater drift. The course was held until ten o'clock, when it was decided to abandon the plan of going south of Roncador reef and take the channel north of it instead; the course was accordingly changed to bring the northern extremity of the reef a little on the port bow.

The noon position corroborated the indications of the morning sight, showing that the ship had not only had a strong set to the northwest, but had drifted about thirty-three miles in sixteen hours, or at the rate of more than two knots per hour; the expected latitude at noon was to be 13° 30′ N., the observation showed 13° 48′; the latitude expected at noon would place the ship nearly abreast the southern end of the reef; the true latitude showed her to be fourteen miles north of its northern point, which then bore about WSW., distant forty-two miles.

The wind dropped during the afternoon, reducing the speed to six knots; fires were spread under the two boilers at 3.30 and the engines started ahead about 4.15, bringing the speed up to eight knots. By the four o'clock position, the north end of the reef was a little on the port bow and fourteen miles distant. A bright lookout had been kept both from the deck and the topgallant yard all the afternoon, for it was known to be low and only visible at a distance of from four to seven miles.

The proposed itinerary that day was to round Roncador before dark that evening, sight Old Providence early next morning, anchor to leeward of Great Corn Island the following night, and run the remaining forty miles or so to Bluefields early Sunday morning.

The sun set that Friday evening, February 2, about 5.45—a yellow, windy sunset—the breeze freshening and scud gathering into heavy masses that promised more than the usual allowance of drizzles through the night. By 6.15 it was dark, and, as noth-

ing had been seen of the reef or breakers, the ship was hauled more to the westward until the danger should be well passed.

At 6.45 it had become very dark, a partially obscured starlight with no moon; the breeze moderate to fresh from NE. by E.; a short, hollow sea covered with long lines of breaks and whitecaps, themselves so very like breakers as to render the real ones very difficult to distinguish except at short distances. The ship was then under steam (half power), topsails, topgallant sails, royals and jib, wind about two points on the starboard quarter, yards square, course W½S., logging eight knots.

Ten minutes later a lookout on the forecastle sang out "breakers on the port bow," followed by "breakers ahead" and "breakers on both bows"; in a minute more the ship had stranded in the midst of three lines of breakers, running from eight to twelve feet in height. The men were mostly on deck at the time, but only a few officers were up, the majority being still at dinner, which had been served a little late that night; in fact, the officer of the first dog-watch had just commenced his meal.

The first alarm brought every one to his station as soon as he could reach it in the inky darkness; the officer of the watch promptly ordered "hard aport," gave the orders for taking in sail, to back the engines hard, put on the blowers and get up steam in the other two boilers.

The ship obeyed her helm very slightly if at all, but took the ground so easily that no spars or gear snapped or carried away even under the press of canvas and fresh breeze. The anchors were on the bows, but could hardly have availed had they been off and ready at the first alarm; she had run in on the breakers at a place where the change from deep to shoal water was very abrupt and the bank narrow (Plate I.).

There was a hope at first that she could be backed off; the sails had been taken in and furled rapidly without jam or hitch, and the men about decks were sent aft on the poop to bring her down by the stern. Encouraging reports came from the chains that she was going astern, but the quartermaster was using a light lead that swept along with the sea; a heavier lead soon told that she was forging higher on the reef with every sea. An anchor astern was the only hope without more steam, and it was getting very late for hope from that.

She seemed, however, not to leak at all, a fact that rather surprised us, as it was the general impression that she had grounded on rocks. From the very first she pounded hard on the bottom, the thumps increasing in severity and, after fifty minutes, when her stem reached the solid wall of the barrier reef ahead, she butted into this as well, and so hard that it seemed as if a few more minutes of the double treatment must surely break her up.

The topgallant masts began to whip and were sent down. All ports were securely closed against the entrance of water, the sea getting aboard only over the poop and that mostly in a heavy spray. The hatches were covered, but only the low ward-room hatch was battened down. Those over the fire and engine rooms had to be kept partly open on account of interference with the draught.

The flood-gates had been closed and pumps kept going, at first to assist in backing off, later from a general fear that she would slide off the rocks and sink in deep water; nothing could be seen ahead, whilst around the ship was only a seething mass of breakers, through which nothing of the nature of the reef or bottom could be distinguished, and all reports from the lead indicated a broken, rocky bottom.

The first soundings were: 15 feet along the starboard side; 16 feet along the port side, 12 to 15 feet, or rather less, under the bows and ahead, and 20 feet under the stern; the draught at the time, with 140 tons of coal in the bunkers, was 13 feet forward and 15½ feet aft. These soundings were taken with a light lead, probably fourteen pounds, and were therefore much in error. The correct soundings were probably much less, as the lead drifted badly with the sea and current; by the time she had reached the barrier reef ahead, the depth was fully two to three feet short of her draught.

She appeared to have taken hard all along her port bilge, being free to starboard and heeling in that direction about ten degrees. For ten or fifteen minutes she thumped mostly along the bilge and on the bottom, with ominous, threatening, cracking sounds in the quarter-deck and about the mizzen mast. These were due principally to the weight of the 8-inch rifle which was gradually crushing its way through the weak deck.

Orders were given to throw the gun overboard, though reluct-

antly owing to the fear that the ship might bilge against it and start a leak, but saving a foothold had to be the first consideration.

Stories have been told in the service of the difficulty of throwing one of these 8-inch converted guns over the side, and it was more than corroborated in our case, for it required the hardest kind of effort on the part of forty men for one hour and a quarter to accomplish it with a ten degree heel at the start. This was made a slower process than otherwise it might have been by reason of the tangle of running gear on the deck, so likely to catch the men's legs or bodies; the decks had been cleared up once but soon became littered again.

Having stripped the gun it was run out hard against the hurters, but only canted muzzle down. The crew then raised the in-board end of the slide, resting it on a halliard rack, and ran the gun out hard, prying it up with a bar, but with the same result as before; tried it again with a tackle to the gig's strongback, the strongback buckled but the gun held on; next hooked the main and mizzen pendant tackles, but could not get a strap to hold without putting in the cascabel pin, a rather dangerous experiment if not rendered absolutely necessary. Finally the pin was put in, all hands manned the tackle and the gun went over unreeving the tackles with a rush, the blocks smoking.

The relief to the ship was immediately apparent; her stern swung slowly to starboard, pushed by the current against the wind and sea, until the starboard bilge took against the bank, stopping finally at the heading SSW$\frac{1}{4}$W., which did not afterwards change.

The wind and sea were now on the port quarter; the current, setting to the northward and westward, on the port bow; the action of all three gradually raised her starboard bilge up the bank, heeling her slowly to port. She seemed to roll and pound more easily in the new position. The butting into the rocks ahead grew less and the cracking sounds aft disappeared. She was more comfortable all around as far as breaking up was concerned, but the heeling increased and heavier seas broke over the stern and port quarter, and over the rail as far forward as the gangway. Orders were given to throw the port battery overboard, but were countermanded from fear of taking water through the ports, and of bilging on the guns on the bottom. She had already swung

right across the 8-inch rifle and, it was thought, had been somewhat injured by it.

It was then a little before nine o'clock. Provisions for the boats had long since been on deck; indeed, it had not taken more than five minutes to get up the allowance from the time the order was given.

The pumps showed no leak that was not under control even after swinging over the gun. Oil had been in constant use over the stern and quarter, proving only a partial success, for while it smoothed the seas alongside a little, the surf prevented it from spreading out astern where it would have done most good. Much of it came aboard with the seas, making the deck very slippery to port, but this was managed by a liberal use of sand. Although the water came aboard frequently and at times in quantity, it shed off readily through the scuppers, which were carefully watched and kept clear of gear and the boat provisions.

About nine o'clock a heavy sea struck the second cutter, the port life-boat; the after fall unhooked and she went down hanging by the forward fall; this cut away she drifted quickly ahead, struck the rocks, turned bottom up, and remained quietly all night, about forty yards ahead and to starboard of the flying jibboom, as if on a beach. This fact greatly encouraged the men, as it seemed probable that the ship had struck right on Roncador Cay; it was too dark to see beyond the immediate vicinity of the ship though the second cutter and the rocks ahead could be plainly seen by the light of the signals fired every half hour.

The engines were kept backing steadily until ten o'clock, racing slightly; they could not help matters much, but were kept at their best speed at half-power awaiting more steam from the other boilers. These were about ready, when an auxiliary steam pipe burst, ending the vacuum and stopping the engines. The engine power was small at best, being only 750 horse-power; the engines were of the old style simple-engine type and had been taken out of the Nantasket, a smaller ship. Steam now poured out of the broken pipe, rendering the fire and engine-rooms untenable, but before coming on deck the engineer's force raised the safety-valves, opened the doors and started the pumps on the boilers and bilge; the bilge pump continued to work until nearly two o'clock.

The temperature in the ward-room and steerage soon rose

above the critical point for the gun-cotton and that was all brought up together with the detonators and thrown over the taffrail, drifting well clear of the ship.

The boilers broke adrift about 10.30, bulging up the fire-room plates and spilling out the fires on the ship's floor; a volunteer force went below and put out all fires, assisted by a hose from deck; the heat of the steam was intense, and a number of men were sent on deck supposedly scalded, but they fortunately recovered in a short time.

The ship still pounded continually, sometimes heavier, sometimes lighter, with an increasing roll to port, until at about eleven o'clock the rolls were from almost even keel to over thirty degrees with hard pounding and grinding under the forefoot; it looked as if she would roll over unless relieved of some of the top hamper; accordingly, orders were then passed to cut away the foremast, but to hold on to the others for a retreat to the rigging if made necessary.

It was not necessary to cut into the mast, the starboard laniards were cut and then the stays: as the last stay parted the mast toppled, breaking off square at the deck, the heel charging across the forecastle like a battering ram and carrying the fife and pin rails before it; it then launched quickly over the side, carrying along all but ten or fifteen feet of the tough main-topmast and the port main-topsail yard arm, leaving the broken yard hanging by the jackstay and sail. The head yards and upper masts drifted away, the stump of the foremast hanging by the gear under the weather bow.

No one was hurt, in fact injuries and casualties were few all night; a couple of men were hurt forward later but went back to work, and a bruise here and there constituted all the rest.

The ship righted when the foremast fell, and was much easier from that time on throughout the night; she thumped frequently and hard with a light roll of from five to ten degrees. Water came on board but shed off well, rising often to the height of the gun-ports in the port gangway. She leaked but little, and from midnight on every one was disposed to stay by her until morning could indicate a basis upon which to form other plans, with every prospect that the ship would hold together, as far as that wind and sea were concerned, perhaps for days.

It can best be said here that from the first there was no noise, no confusion beyond what the darkness of the night occasioned; some who were timid of their swimming abilities put on life preservers (there were forty-five all told in the ship) but soon took them off. While the executive kept the deck the night through, the regular watch officer looked out for things aft and superintended the signaling or the work where other officers were engaged along with their men.

What preparations could be made for the approach of daylight were now pushed ahead. Three rafts were constructed from the light spars and lumber, their heads resting on the rail forward, all being ready to launch in case the other boats should fare no better than had the second cutter. As much extra provision and fresh water as possible was brought up, limited only in amount by a desire to keep the gangway clear for a rush forward in case she should break in two.

The galley fires were started and coffee was made and served out, reinforced by cigars and cigarettes from the wine mess stores. The men kept at their work singing cheerily a number of 'Shantee songs, the most popular being "Heigho, knock a man down" and "No more I'll go a-rovin' with you, fair maid."

It had been quietly reported from time to time that water was rising in the fore-peak from the leaks about the stem where the hooding ends of the planking had been sprung off by butting into the reef ahead. But this was shut off by the forward flood gate and did not run aft to the well. The water in the after well was easily kept down to three inches or about the sucking level of the pump; the forward well, showing no water, was unrigged and the men sent to the after one. After the steam cleared in the engine room, soundings were taken on the port bilge and showed but ten inches. This condition did not alter as long as the pumps were going. At 4.15, all work was stopped for a general rest; pumping was resumed at 5.15, and continued until 6.00. There was then only six inches in the after well and fifteen inches on the port bilge near the condenser; after 6.00, no pumping was done.

Daylight broke Saturday morning at about five o'clock, but a series of trade rain squalls, with overhanging clouds, kept it too dark to see well until quite near six. The view at good daylight showed a serpentine, triple line of breakers extending away off to

the southern horizon, overhung with mist, the heaviest break being about a half mile off the port bow where the bank seemed to extend well out to seaward; to the westward of this, within the reef, was a large sand patch, its rounded top just plainly seen above the surf, and near it was a part of the stem and keel of some wreck, supposed to be that of the Aguan, lost on the reef on a voyage to Greytown; not far from the wreck was a drifted tree that had earlier been mistaken for a fishing vessel standing down to the ship. To the northward was a continuation of the breaker line but, so far as could be seen, the breakers there did not look so formidable as those to the southward; the ship had struck at the beginning of the lighter break in a sort of V-shaped pocket, the southern side of the V running nearly east and west.

Everywhere to the westward of the breakers the water was smooth, with only a light swell just within the breaker line; in the center of this smooth surface and toward the western side, the water showed a narrow green streak, a deep channel in the shoal that elsewhere took on a brown tinge except where black spots indicated detached boulders or rocks. Under the bow could be made out the general configuration of the formation, that of the usual coral atoll, a solid wall of coral a hundred and fifty yards wide, its top just awash at low water, fronted by a bank of coral sand and rocks on the seaward side, extending out for perhaps five hundred yards to where the bank broke off abruptly to a hundred fathoms. The bottom was very white and strewn with boulders of all sizes covered with a depth of water from eight to ten feet, through which the eight-inch gun could be plainly seen off to port. The wash against the weather side had worn the face of the barrier wall into detached coral heads that stood up like the columns of a portico; between two of these the stem had firmly wedged, occasioning the springing of the hooding ends of the plank about the stem, and the leak in the forepeak.

Abaft the starboard beam, bearing about WNW., could be seen what appeared to be a long nest of rocks, like those sometimes seen extending out from a point of land where the rise and fall of tide is large, but not till looked at with the long glass could anyone realize that it was the island charted as Roncador Cay, the only good foothold on the reef. It was more than a mile away, and but two places could be recognized as the huts said to be there,

though what seemed to be smoke was rising over them. The smoke proved to be flocks of booby birds that we became better acquainted with later.

The brown water on the shoal within the barrier reef appeared to be only a few feet deep, at most not over a man's head. The sea along the starboard side of the ship was a smooth swell running over not more than six or seven feet, and much less under the bow. It was dead low water; the heavy seas running under the bow and stern, breaking up as they struck the barrier wall, made only a light swell across the shoal, and taken all in all there seemed to be a good fighting chance to get everybody safely over the breakers, transport them to the island and save a fair share of provisions and water besides, together with implements for sinking wells for water for culinary uses.

The gig, manned by a volunteer crew, was first tried. She rode safely alongside, fended off with boathooks and held bow and stern by lines, was piloted between the heads by direction from the forecastle and got over the rocks without any mishap. The men jumped out in water that was only waist to shoulder high and waded back to the second cutter. Lines were floated in to them by gratings and then the end of a hawser which they secured to coral rocks on the shoal. A raft was next lowered to carry in a kedge anchor. Manned by three men it started, but had scarcely reached the barrier when it rolled over and over; the men held on and went over finally without injury. The hawser was well anchored on the shoal, and more lines were sent over the bows and head booms.

After the whale boat had been lowered the dinghy was transported to her davits and lowered from there. She hoisted astern and had been badly pounded during the night by the sea against the awning stanchion, resulting in a hole in her port bilge. This was repaired as well as possible before lowering, but she was not of much use that day.

Lowering the sailing launch was not quite so easy, owing to the list to port and rolling added to the fact that the davits would not rig out far enough to clear the side on the lee roll without endangering the boat, which was the main dependence for sending for assistance when once ashore. Lowering the steam launch was about the only practicable way out of the difficulty of heel. A

PLATE I.

RONCADOR BANK.

From a British Survey in 1835.

Roncador Cay } Lat. 13° 34′ 30″ N.
South point.... } Long. 80° 04′ (05″) W.

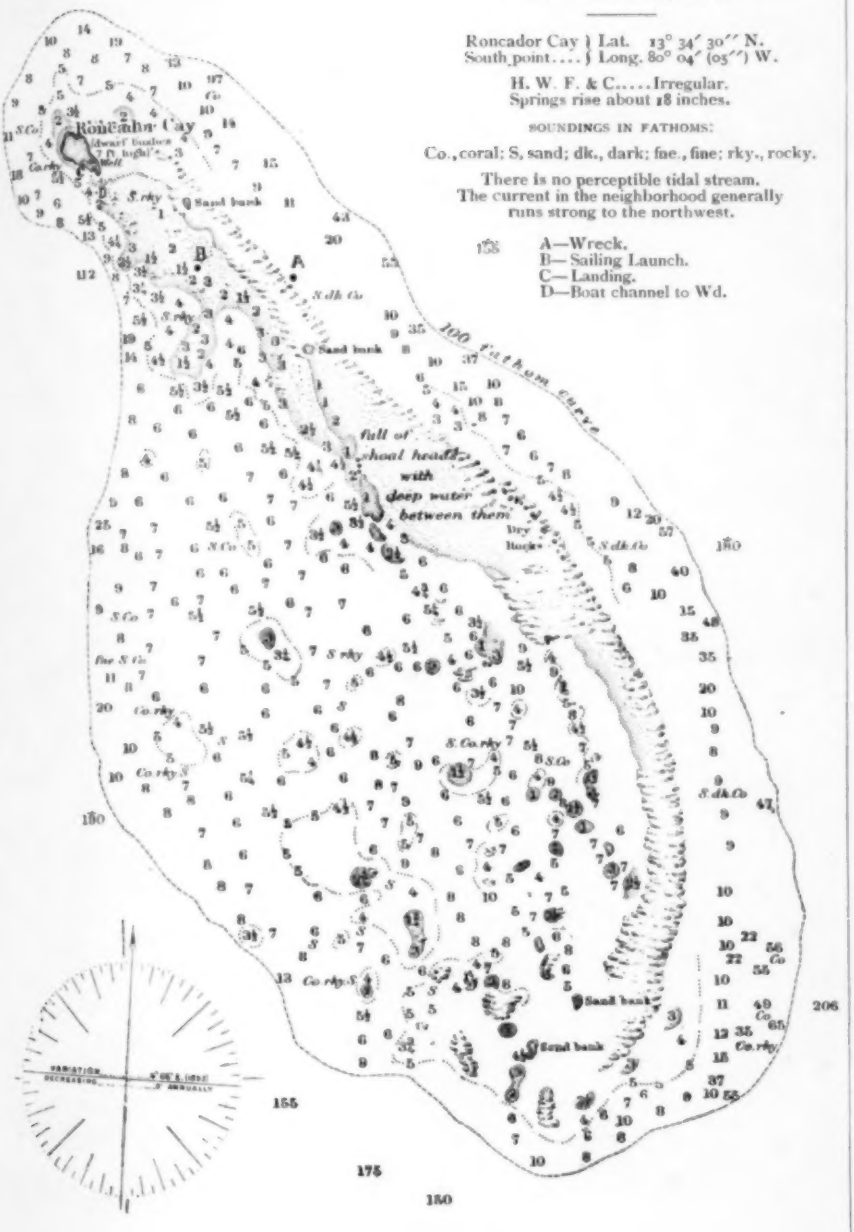
H. W. F. & C.....Irregular.
Springs rise about 18 inches.

SOUNDINGS IN FATHOMS:

Co., coral; S, sand; dk., dark; fne., fine; rky., rocky.

There is no perceptible tidal stream.
The current in the neighborhood generally runs strong to the northwest.

A—Wreck.
B—Sailing Launch.
C—Landing.
D—Boat channel to Wd.



new boat, if only she could once be gotten ashore, she would be only second to the sailing launch for any purpose. Efforts had been made during the night to take out her boiler and lighten the draft, but the holding down bolts could not be taken out; the men were working in a place made dangerous by the seas breaking over the rail and had to be called out. There was, therefore, little chance of saving her in the morning. After working awhile in an endeavor to lower her, she had finally to be cut away, when she drifted ahead, bilging against the stump of the foremast and rocks, and turned over wrecked on the reef beside the second cutter. The ship righted a little, however, enough at least to lower the sailing launch safely by breasting out with spars and oars. The third cutter stowed in the launch and had been hung to the davit-heads whilst lowering the launch. She was now sent down, breasted out as the launch had been.

Much of the fresh water, the ship's papers and a few provisions were passed into these boats, a light load to each; all boats were then sent over in charge of their own officers and crews without a serious bump. The sailing launch with her two-and-a-half foot draught did not get a scratch. The only boat still on board was the first cutter, the best of the pulling boats. There was no way of transporting her to starboard; when cut away she charged forward to the same fate as the other two that hoisted to port, and both cutters later drifted away to sea.

At 8 A. M. the colors were set at the peak and never hauled down again; they were still flying when we left in the Para a week afterwards.

The rafts were condemned as a means of general transportation, it being evident that, even if they carried over safely, their rough and jagged ends would not permit of their being hauled back to the ship again over the rocks. The catamaran, a new boat of the double cigar-shaped, wooden float type, was then tried as an experiment, using a line to the men on the shoal and a return line to the starboard pivot port. Three men went on her first, and crossed easily, guiding themselves clear of the rock-heads by taking the hawser under their arms. She did the yeoman's service of the day, making trips continually, carrying men, water breakers and casks, provisions and canvas, until the last man had been put over the breakers. She never capsized, nor was

any one who crossed in her injured in any way even to the extent of a bruise. She would often ground as she passed over with her load, sometimes two or three times on the same trip, but the next sea would raise her and carry her on.

The ship was now cleared of men by four to six at a time, and as much fresh water and provisions were saved as possible. All spare breakers, including those used by the cooks for vinegar and molasses were filled from the tanks and carried over by the boats and catamaran, but it represented only a meagre supply, perhaps 160 gallons all told that was fit for drinking. There was nothing else, however, to put water in except the vinegar barrels in the hold that were filled later for culinary use.

The provisions were merely thrown overboard and allowed to take care of themselves, the men on the shoal picking them up as they came across. They all floated well when boxed, even heavy articles, such as tinned beef and mutton, floating across in their cases as if buoyed by cork. At first they were thrown into the stiller water to starboard, which resulted in keeping them circling there in the eddies and endangering the catamaran and men ; after that they were consigned to the breakers to port and crossed much more quickly and with little loss or injury.

The bread and coffee fared badly, for, in filling up before starting south, the boxes had to be stripped from the tins in order to stow the allowance. As soon as a bread or coffee tin struck the rocks the soldered seams would give way somewhere, but the bread would generally carry over, though in a damaged condition, while most of the coffee would spill out under the bow.

Arm-chests were emptied, filled with ward-room stores and a few table utensils, thrown overboard and picked up on the shoal, their contents unharmed. Pork and beef barrels sank like lead alongside, naturally, but unregretted till later when the want of pork for soup-making became a marked inconvenience. Black bags were pressed into service, filled with clothing and other useful articles at hand, and of all stores and articles thrown overboard perhaps seventy-five per cent. arrived at Roncador Cay. It represented a hard but successful day's work ; for besides, the men were otherwise engaged in hauling the catamaran ashore and tending her as she went back ; were working breast high against a current which in three days carried a chest from the shoal to Old

Providence island, eighty miles distant, and were in the main shoeless from a policy of being ready to swim for it, which occasioned badly cut feet or bruises from the sharp surfaced coral boulders, exhausting their strength against the swells near the barrier, under a broiling sun, and with hard pulling in loaded boats.

The sailing launch had been anchored in the deeper water back from the breakers as soon as she arrived over the reef, and had been made a receptacle for men and provisions. The gig made a trip to the cay, exploring the boat channel, and on her return all boats engaged in carrying up the stores and men from the launch and in towing the loaded rafts.

A strong effort was made to get out the steam launch's boiler for condensing purposes and save the boat, but neither could be moved. It was tried again a few days afterwards but with no success.

By three o'clock all stores, officers and men had arrived at the cay. One coal passer, who had endeavored to wade up to the cay after he had come over to the shoal, and who in swimming across a deep place in the shoal had become exhausted and gone down, was the only one out of a grand total of two hundred and four, officers and men, who was lost or injured.

The ship was now listed about twenty degrees to port, foremast gone, main lower mast with broken topmast and topsail yard still standing, the broken yard arm hanging, the mizzen mast and head booms intact, the flying-jib trailing under the boom, the colors flying and the admiral's flag fluttering in the crotch of the mizzen-topmast stay. The fore-hold was still dry, there were two feet of water on the forward fire-room floor, water over the engine-room platform and ward-room floor. A few seams had opened in the waist, but that included all injuries that could be seen along the side. She was nearly six feet short of her draft fore and aft, but was more solid on the ground since the water had come in, doing little rolling and pounding. An attempt to board her was made on Monday, a little too near high water to make it a success however. A number of people went on board during low water on Tuesday and Thursday, securing a quantity of bedding, clothing and provisions. The water had then risen inside to a level running from the waterways of the spar deck, under the tops of the port state-room doors to the tops of the lower

tier of drawers under the bunks of the starboard rooms, and the cabin had suffered from the wash over the skylights. She was neither pounding nor rolling.

THE WEEK ON RONCADOR CAY.

Roncador Cay, the largest of several sand bars formed of the washings from the barrier reef, is piled up at its northern limit and is barren and uninhabited. In the spring of each year fishermen come from the surrounding islands to catch turtles, while for the remaining seasons the cay becomes a refuge for large numbers of birds, mostly of the "booby" variety, that nest here, or the man-of-war hawk that preys upon the young.

The cay is pear-shaped, trending about NNW. and SSE. with a total length of 600 yards, its widest part at the north, with an extreme width of 300 yards. The highest part is perhaps seven feet above mean low water, but the cay is protected against the ordinary trade seas by the barrier to the eastward. The rise and fall is between eighteen inches and two feet.

Two rises of from eight inches to one foot, probably the marks of very high tides or hurricane wash, divide the cay into practically three terraces of which the northern is the highest and comprises fully three-fourths of the total area; this part is thickly strewn with boulders of from one to three feet in diameter, its upper edge is fringed with small heaps of guano collected for shipment, and at the northwest point are six huts built of loose coral stones, roofless but fitted with rough doors and windows. It is supposed that these huts were built by four men who were left here some years ago by a guano company, three of whom were rescued by the Powhatan about fourteen months later; though in the very best location for a camp, both on account of their dryness and protection from the fine, drifting sand, they could not be used, owing to the large amount of guano in and around them.

The middle and southern terraces form the small end of the pear and are sandy with broken coral and shell, but no boulders. The middle terrace is covered with a sparce growth of wild parsley, the only vegetation on the cay; the southern terrace is of finer sand and shell, and near its upper end are two fishermen's huts of

A-tent shape built of branches, boarded to windward and thatched with palm leaves.

No especial attempt was made on Saturday evening to get matters into shape beyond preparing for a night's rest in a sort of bivouac style. Efforts to dry clothing had been only partially successful, the effects of sunburn began to come into evidence and everyone was tired from a sleepless night and hard day's work. The carpenters built a signal mast in readiness to raise with an ensign or commercial code "NC" in case the ship's mizzen mast fell. A well was sunk with the intrenching tools near the point marked "well" on the chart, but caved in immediately as the sides had been made too nearly perpendicular. Enough water was, however, taken out to show that it would clear quickly and would answer for culinary use, if not potable.

A muster was held and directions given to prepare the sailing launch for departure next evening to Old Providence Island for assistance. An allowance of half a pint of fresh water apiece was then served out for making the evening's coffee, and a detail sent to collect wood for the morning fires. An inventory of stores showed fresh water for six days at an allowance of half a pint per man per day, provisions for nine days at half rations. The fresh water was stowed in the upper hut, the remaining space being set apart for quarters for the Admiral and Captain, its only furniture two arm chests for beds. The provisions were stacked up near by under guard of a sentry, who also guarded the other hut in which were stowed the few medical stores that could be brought off in hand-bags and $14,000 in gold that had been saved by lashing it up in a small traveling bag.

Quarters for the night were necessarily rude and merely intended as a shelter from the passing drizzles of rain—canvas stretched to oars and poles, boat sails around a tripod of oars, and lean-tos of canvas with lumber or driftwood. A more pretentious covering was constructed out of the quarter-deck awning supported at the center by the stump of a topgallant mast, with a rope backbone led over crossed oars and set up to stakes. This arrangement, however, almost collapsed before morning. All those not provided as above slept under the boats.

The night turned out surprisingly cold. Against this the shelter used was no protection; besides, the sand drifted in everywhere

and the land and hermit crabs crawled over the sleepers, their sharp claws proving a great annoyance.

The new quarters, strung along the weather side above the shingle beach, were successful in keeping out the sand, but all efforts against the intrusions of the crabs proved only tentative. The fourteen officers not accommodated by the huts built an A-tent out of a piece of the quarter-deck awning, closing in the weather end by a wall to near the top and the lee end with signal flags. The opening at the end could be closed during the cooler portions of the night and left open to the breeze during the heat of the day. It was very comfortable barring the fact of a hard bed, for, though the sand was soft, it was anything but soft to lie upon, as many a sore hip-bone and shoulder could have testified. The parsley would answer for a night and then wilt; oakum was better, but required re-picking daily.

The men constructed quite comfortable huts out of canvas and lumber or driftwood, tents of boat sails around a tripod of oars, lean-tos of the same materials, or else slept under the boats. Perhaps the most successful of these structures was a lean-to made of boards and canvas, the weather end supported on a wall and merely propped on the other side; it was easily accommodated to the conditions and had a large stowage capacity. The tripod tents insufficiently accommodated two and scarcely paid for the amount of canvas needed for their construction.

Those who slept under boats fared worst. The boats were required for use during the day to the exposure of personal effects, and so much banking in with sand was necessary at night as to almost exclude fresh air. But, taken all in all, everyone became fairly well housed within a day or so, and, had there been sufficient blankets for covering, all would have been quite comfortable under the circumstances.

The daily routine comprised meals at seven, twelve and five for all hands, and a muster at 8.30 when the divisional details for necessary work were made, principally for collecting wood. From eleven until three no one was allowed in the sun; then tattoo at nine ended the day. The watch officers stood a regular day's duty and alternated with the juniors in a night patrol. A quartermaster was kept at the lookout day and night, and sentries over the provisions, water, quarters and wells.

Two new wells were sunk in the center of the widest part of the cay and a good supply of water found at a depth of six feet, brackish in taste but sweet, somewhat resembling dilute cocoanut milk—merely sea water filtered through sand. One pint of fresh water per man had been served out Sunday morning as the day's allowance for drinking purposes. It had never to be repeated, for not only did the water from the wells answer for cooking, but proved so satisfactory for drinking as well, that it was ordered to be used until some deleterious effect should necessitate the use of the fresh water in the casks. No one seemed to be affected at all by this well water in the five continuous days it was used, and whatever might have been a later effect, especially as regards a laxative, particularly undesirable with short rations, no such effect was anywhere evinced during that time; little water was used for drinking, however, both from a practice of taking only a single swallow at a time and from the large amount of liquid received in soup. Nevertheless, a supply of fresh water was made one of the especial directions of the launch's orders on her departure, for the rain at the cay scarcely wet the canvas it fell on and none could be caught.

The sailing launch with two officers and eight men left about five o'clock Sunday evening under orders to go to Old Providence Island, eighty miles to the westward and leeward, and hire a fishing boat to take one officer to Colon, the other to remain with the boat and men until joined by the remainder (from the cay), and meanwhile to load a second vessel with water and fresh provisions and despatch it to Roncador. No vessel being obtainable at Old Providence, the launch was to call at St. Andrews and then proceed to Colon.

She was fitted out with a canvas forecastle, navigation instruments and books, a chronometer that had crossed the breakers, and was given the regular half ration allowance for her complement for one week.

She had not disappeared from sight when a heavy rain squall ushered in the worst night we had whilst on the cay, a night of strong gusts and extreme darkness, and, though the boat was new and strong and regarded as quite equal to any ordinary wind or sea, she was from that time the reigning anxiety. The most sanguine could not but consider the possibilities of over-running in the darkness and missing the islands altogether, with the favoring

current and squalls, or of setting on the reefs to the northward of Old Providence, as dangerous as Roncador itself, or of shipping water if compelled to lie to, added to the fact that the mast was a little frail for her spread of canvas under lighter conditions. But above it all there was a general feeling that she could make Colon even if she missed the islands. A "preventer" plan was arranged,—to deck over the gig or cutter for a direct course to that point, about three hundred miles due south, in case nothing should be heard of the launch in two weeks.

The launch stood on that night, making much better weather of it than could have been supposed, her only difficulty a buckling mast that was soon secured with extra shrouds. About two o'clock in the morning, she lay to for two hours, and then bore away on her original course, picking up the south end of Old Providence nicely at daylight. Abreast the point the wind shifted suddenly to due north, compelling a dead beat up to the town of Isabel, which was reached about noon. The first schooner was out for Colon that night, arriving Wednesday evening; a second, loaded with fresh water and two thousand oranges, reached Roncador just as the last boat arrived alongside the Para when we were quitting the cay.

To the credit of these fishermen it should be said that they accepted $100 for their charter to Colon, and $37 for that to Roncador reef, including the cargo.

An endeavor was made on Monday to board the ship, but failed owing to the high stage of the tide and breakers, the latter much increased by the squalls of the preceding night.

Efforts on both Tuesday and Thursday were successful and some clothing, blankets and bedding were secured, together with all the stores in the bread-room on the steerage country. The tanks were found entirely submerged, thus ending any hope from that source. On Thursday the ship was surrounded by sharks, and a rather large one was swimming about on the shoal near the boat.

The additions from these two visits brought up the total stock of provisions to a three weeks' supply on half rations, but fortunately the resources of the cay in the provision way placed that question beyond concern. Fish were plentiful and easily caught with a bait of conch meat. Besides the well known red snapper and skip-jack there were several unusual varieties, amongst them a graceful, pinkish fish resembling trout and having a bright gold stripe along each side. The hooks and lines came from the boat

boxes, but the supply was quite inadequate to the necessities of the case. The majority of the hooks were too large for that sort of fishing and could not be used. It so happened, however, that one of the quartermasters had stowed some smaller ones in the signal chest, and they had fortunately been saved with the chest. The deficiency in lines was not so difficult a matter, as ravellings from cotton canvas answered every purpose.

Snipe and plover were numerous and tame, but there was no fowling piece either on board or ashore. Conchs, red crabs and pecks of periwinkles and shell-fish were picked up along the beach together with a few grey prawn of large size.

Had all these failed, the booby birds were on and about the cay in thousands, and probably would not have deserted it. They seemed to frighten only at some unusual noise, the sound of the bugle for example, and so tame were they that walking near the nests would only cause them to rise on their feet in order to strike with their beaks.

When plucked their flesh suggests that of a tame goose, though the meat is quite dark, and has much less of the fishy taste than that of the ordinary fish-feeding birds. If young and roasted they might perhaps afford a fair relish, but our cooking arrangements consisted only of a trench in the sand, together with an old ship's range found on the cay, and which had neither pipe nor lids. So soup making was almost the only thing possible, considering the brief time that fires could be allowed.

So birds, fish, crabs and salt pork went into a common kettle with water from the wells to cook the only dish.

Birds' eggs were as numerous as the birds themselves and quite as palatable as duck eggs. Whilst there was a theory that the birds would not set until they had laid two eggs, and one egg in a nest was therefore sure to be a good egg, the fact proved to be that there were really but few good eggs at that season notwithstanding the large number of one-egg nests.

Many, no doubt, intended to settle for themselves the much disputed question as to the tenderness and toothsomeness of a young booby through the instrumentality of a fine, half-fledged gosling in a nest near the officers' tent. But it disappeared "between two days," and within the mind-recesses of two reticent naval cadets, who have perhaps the only knowledge, is locked up the solution of the dispute.

There was a sufficiency of provisions at all times except in the matter of bread. So much had been soaked with salt water that but a small amount of dry bread was available from the stock on hand. Even in so hot a sun efforts to dry it failed. It became encrusted with sand, mildewed and turned black, until fully fifty per cent. had to be condemned.

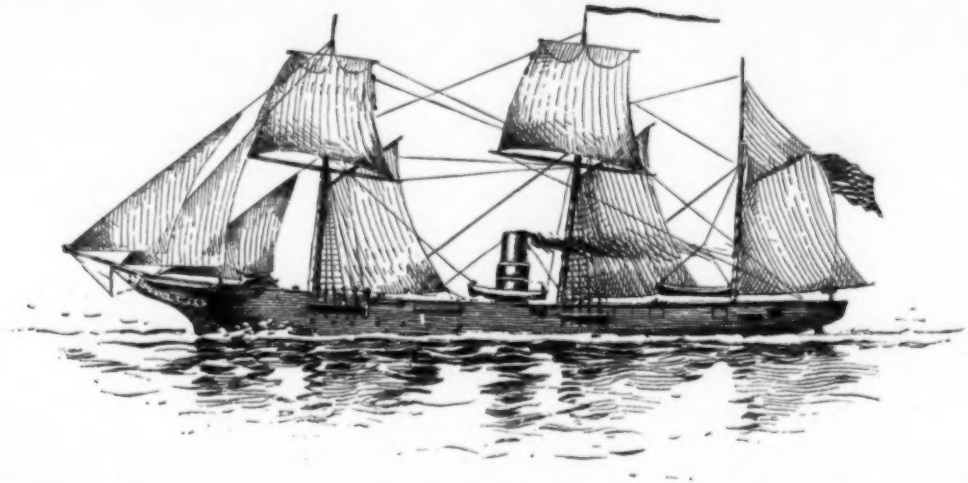
The original allowance was six hard tack per man per day; by Monday it had been reduced to four, and after Wednesday was reduced further to three, and much of that was black and sandy. There was a large amount of flour, but only a very little baking powder and about five pounds of water soaked hops.

The coffee was made to answer on the allowance by saving back a little to add to the grounds of the morning; by evening, the infusion resembled weak tea. There was one fifty pound chest of tea in good order.

No sickness that could be directly traced to the life on the cay manifested itself. The discomforts were largely due to sun-burn. Few thought to protect their necks and faces with a towel or cloth, or stopped to consider the effects of exposing their bodies when drying their clothing. Next day the results manifested themselves in large yellow blisters on necks and noses, and cracked lips or skin which the sand made more irritating. Treatment with carran oil liniment afforded some relief, but it was days before many had entirely recovered.

On Saturday morning, February 10, the cutter was sent down to the ship to get a spar for firewood, and a party of officers were fishing outside the reef, and having excellent luck at that. About 9.30, a cry of "Sail Ho" was passed along the cay, and the signal mast was quickly raised with an ensign at the truck for fear that it might only be a passing vessel. The alarm was not credited at first, as several of the same character had been raised during the week through mistaking flocks of birds on the horizon for smoke. But the masts and smoke-pipe were soon made out, then the build of an American steamer, and finally the Columbian Line colors and a commercial code signal to embark.

All the people, boats and effects were on board by half past one, and we weighed anchor for Old Providence, taking the launch and her people on board about 1.30 next morning, and arriving at 11.00 the same night at Colon.



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THE KEARSARGE IN 1864.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE GUN IN NAVAL WARFARE.

By P. R. ALGER, Professor of Mathematics, U. S. Navy.

There are but three weapons of offense in naval warfare,—the gun, the ram, and the torpedo. The hand-to-hand fighting of former days, when ships were lashed together and the 1st lieutenant lead the boarders upon the enemy's deck, has gone never to return, and this method of fighting no longer needs consideration. But the question whether the gun, the ram, or the torpedo is to be the chief factor in future naval battles is one of the deepest interest, since upon its answer depends in large measure the system of training which we should establish in time of peace, and the tactics which we should adopt in time of war.

Had the question been asked but a few years ago which of these three weapons was the most important, an overwhelming weight of opinion would have been found upon the side of the ram. Captain Coulomb, in his paper on "Lessons from Lissa," said, "The serious part of a future naval attack does not appear to be the guns but the rams." Admiral Touchard said: "The beak is now the principal weapon in naval combats." Capt. Pellew, in his lecture on "Fleet manœuvring," said: "Rams are the arms of naval warfare to which I attach the chief importance." Capt. Noel, in his prize essay, said: "In a general action I do not hold the guns to be the principal weapon," etc. But of late years, this view has been greatly modified, and to-day, I believe, the best opinion is once more in favor of the gun. The torpedo has never been considered more than an auxiliary, and by many is looked upon, as far as its use for ships is concerned, as merely a defense against the ram. To indicate the general change of opinion which I have mentioned,

the following quotations from comparatively recent articles will suffice. Vice-Admiral Nicholson says: "I do not think anyone would be so mad as to attempt to use his ram early in action, and I doubt very much whether in a single action the ram would ever be efficiently used, except to deliver the *coup de grace.*" Mr. W. Laird Clowes says: "To endeavor to effectively ram a ship that has sea-room and is under control is hopeless, even if she be of greatly inferior speed." Admiral Long says: "I shall assume that an artillery duel will form the first phase of a naval engagement, the object being to engage beyond effective torpedo range until the enemy's battery is much reduced in power and his exposed torpedo discharges are rendered useless," and "Success in naval battles will more than ever depend on the effective working of the guns." Comdr. Sturdee, in his prize essay for 1893, says: "Of these three weapons, in my opinion, the gun takes the first place, the torpedo comes next, while the ram comes last," and "Broadly speaking, ramming should not be resorted to unless some distinct advantage is evident, such as meeting a ship disabled or at anchor."

For myself, I am convinced that the last quoted opinions are essentially correct. All history and tradition point to the gun as peculiarly the naval weapon; by it, with a few exceptional instances to the contrary, all naval battles in the past have been decided; by it will they be decided in the future. I hold that the effectiveness of the modern gun is so great that the increased power of the ram, and the invention and rapid development of the automobile torpedo have been unable to oust it from its place as the paramount weapon of naval warfare, and that our training and tactics should be established almost solely with a view to its most efficient use. I shall lay before you the grounds for these convictions, and shall then endeavor to draw some conclusions as to how the gun should be used.

First, let us consider the ram. This weapon, extensively used when war vessels were propelled by oars, and the use of cannon was unknown, fell into complete disuse during the sail period owing to the lack of speed and manœuvring qualities in sailing vessels. It was not till our civil war that the use of the ram was revived, but the tragic circumstances of its occasional successful use during and since that war, and of its, perhaps, more frequent

accidental use, gave rise to exaggerated notions of its importance. A table prepared by Mr. W. Laird Clowes, and published in the Royal United Service Institution for March, 1894, gives a detailed list of 74 cases of attempted ramming in modern warfare, including all the cases which Mr. Clowes was able to obtain knowledge of as having occurred since 1860. A summary of this table shows that, of the 74 vessels attempted to be rammed, 36 entirely escaped, 18 were slightly damaged, 5 were seriously damaged, 2 were disabled, and 13 were sunk; while of the 74 vessels which attempted to ram, 56 were uninjured, 13 were slightly damaged, 3 were seriously damaged, 1 was disabled, and 1 was sunk. But, of the ships rammed not one was either disabled or sunk, unless attacked either in narrow waters, when unmanageable, or when at anchor, and of the ships seriously damaged, but one was under steam with sea-room. Mr. Clowes' conclusion, and as far as we can reason from the past to the future, it seems to me well founded, is that if two ships are fully under control and have sea-room, it is more dangerous to try to employ than to try to escape the ram, and that, under these conditions, it is practically hopeless to dream of ramming effectively, since there is no recorded case of the operation being performed, though it has been attempted at least 32 times.

It must be remembered, too, that all these cases occurred before the automobile torpedo had been developed to anything like its present state and before the introduction of heavy breech-loading and light, quick-firing guns. A ship failing to ram must generally pass under the stern of her adversary, and in so doing runs great risk of being torpedoed, stern and quarter torpedo discharges being now almost universal. Moreover, it must not be forgotten that the difference between ramming and being rammed is but half a ship's length, or in these days of high speeds, always less than 10 seconds. If two ships approach each other bows on, they risk mutual destruction, and no advantage is apparent which should induce either to attempt such an attack. If they approach on parallel courses, and either wishes to try ramming, he must, in order to tell when to put his helm over, not only have an exact knowledge of the speed and turning power of his own ship, but an almost equally exact knowledge of his adversary's speed, and, having estimated this correctly, a change of the latter's course or

speed renders his calculations futile. Even great superiority in speed has not availed to make ramming feasible. In the fight of May 21, 1879, the Huascar, 11 knots, only succeeded in ramming the Esmeralda, 3 knots, when the latter's engines were disabled, and the Independencia, 12 knots, made three unsuccessful attempts to ram the Covadonga, 5 knots, running ashore the third time.

The Merrimac successfully rammed the Cumberland, the latter being at anchor, but five attempts to ram the Monitor were unsuccessful. At Lissa, the only modern fleet action, over 40 vessels were engaged in a general mêlée, in the smoke and confusion of which nearly every ship made one or more attempts to ram, but only one was sunk, and this when her steering gear was disabled. Admiral Coulomb has recently well said: "What made the ram powerful at Lissa was not the ram itself, but the unskillfulness of the people who met it." In the action of July 11, 1879, the Huascar made four unsuccessful attempts to ram the Magellanes, and in the action of October 8, 1879, the Cochrane failed in several attempts to ram the Huascar, although the latter's steering gear was disabled, and she was being steered by relieving tackles.

But it is useless to multiply instances. Past experience having, to say the least, illustrated the uncertainty of the ram as a weapon, let us see if there is not good ground for the belief that the future will show it to be still less important than it has been in the past. The peculiar feature of the ram is that every advance in its power and efficiency is necessarily accompanied by an equal addition to the means of escaping it. Protection against gun-fire is obtained by armor, but armor, although developed along with, and in consequence of the development of guns, does not keep pace with them, and, as will be shown later on, the offensive power of the gun becomes more and more superior to the defensive power of ships. Protection against torpedoes is by minute subdivision, double bottom, nets, and perhaps will be attained in the future by means as yet unknown, but the destructive effect of the torpedo has increased far more rapidly than has the efficiency of the defense against it. The ram, on the other hand, becomes more dangerous as speed and turning power increase, but these very qualities are the defense against the ram, and consequently the advances of offense and defense are exactly equal. When 40 knots is a common speed and ships turn in their own length, it

will be no easier for one to safely ram another than it is to-day. I do not say that the collision of ships, with equal chances of destruction to each, will not be brought about more easily, but the chance of one vessel ramming another, and escaping herself will not be greater; rather, it will be less, the smallest error in judgment becoming more and more fatal as speed increases,— and, since it is the very essence of skilful tactics to only engage in such a way as to have the advantage, I believe the ram is destined to be less and less used, and I place it last in importance of the three weapons of naval warfare.

Taking up next the torpedo, — and by this I mean the automobile torpedo similar to the Whitehead and Howell, for the so-called aerial torpedo should be rather considered under the head of guns, and other forms, such as the spar and towing torpedoes, are obsolete, — we are at once struck by the limitation of this weapon, as compared with the gun: its short range, its inaccuracy, and its low speed. It is true, that both the velocity and accuracy of the torpedo have within the last few years been greatly increased, the mean speed of the 18″ Whitehead being now 30 knots for 400 yards and its maximum deflection at that range, when fired from a fixed position, less than 8 yards. But, even supposing this speed doubled, it would still be only one twentieth that of the gun's projectile over its much greater effective range, and its accuracy compares no more favorably with the latter. We have had but little experience with the automobile torpedo in actual warfare from which to judge of its efficiency. A number of vessels have been sunk or disabled by its use, but I believe in every case the attack has been upon vessels at anchor by torpedo-boats. There is no instance of a vessel under way having been struck by a torpedo, and there are but few recorded instances of its attempted use in actions between ships. In practice last summer, the Cushing, steaming upwards of 14 knots and discharging Whitehead torpedoes from a broadside tube, showed that their average deflection at 400 yards range was only about 25 yards, so that every shot fired under such circumstances would have struck a vessel broadside on, but under the strain and excitement of action it is certain that such accuracy cannot be counted upon. In the attack of the torpedo-vessels Condell and Lynch upon the Blanco Encalada, the latter being at anchor, five torpedoes were

fired at close range, but one striking. Lieutenant Moraga, commanding the Condell, is quoted as saying: "At about 100 yards distance I ordered the bow torpedo to be discharged. It missed its mark, passing astern." The difficulty of estimating distances correctly at night and under such circumstances may well cause us to doubt that the distance was as little as 100 yards, but there is little doubt that all five torpedoes were fired at ranges at which, in practice, we could count upon hitting, and the fact that but one did hit shows what an effect the circumstances have.

It is generally considered that 600 yards is the maximum range at which the probability of hitting is sufficient to justify the use of the torpedo, and I think we may fairly say that at the present time a vessel which presents her broadside to her opponent's torpedo tube at ranges less than this runs a very fair chance of being disabled or destroyed. It is even possible that in the future the torpedo may be developed to such a point that within 800 or even 1000 yards it will certainly disable or destroy a vessel broadside on, but even granting this, can we then consider the torpedo as more than an auxiliary weapon for ships of war? I think not. The torpedo will play an important part in determining the tactics of sea fighting in two ways: on the defensive side as a counterpoise to the ram, and on the offensive side as rendering it necessary, at least in the preliminary stages of an action, to keep beyond its sphere of action, but at the best it must play a part subordinate to that of the gun. With greater range of action, with almost as destructive an effect if successfully delivered, and not handicapped by being almost as dangerous to the attacker as to the attacked, I place the torpedo ahead of the ram, and second only to the gun as a naval weapon.

One of the most striking characteristics of all warfare is the continual increase of the distance between the combatants as the effectiveness of weapons increases. Of old, fighting was almost entirely hand-to-hand, with sword or dagger; to-day armies engage almost out of sight of each other, and the bayonet, the soldiers' weapon for close combat, would be abandoned entirely but for its value as an intrenching and pioneer tool. On the sea in the same way, the development of the offense, far outstripping that of the defense, has rendered it impossible to fight as formerly, yard arm to yard arm; such an engagement could not last five minutes. The

reason of this is obvious; men are much the same today as they were centuries ago; they can stand so much punishment before being demoralized and no more; consequently as weapons become more destructive, fighting range increases, and it is only when the enemy is disabled that we dare to come to close quarters. If mutual destruction were the object of fighting, then men and ships might engage as wild beasts do; but, if we desire to destroy the enemy and escape ourselves, wisdom and proper prudence will cause us to engage at a distance, and this distance will become greater as our weapons become more destructive. But if this be so, then, evidently, the weapon of longest effective range will play the most important part, and if this weapon is constantly being further developed so that its destructive effects become greater and greater, then more and more will it become paramount and other weapons subordinate. It is upon these grounds that I place the gun first among the weapons of naval warfare, and I now propose to illustrate briefly the growing efficiency of the gun, which makes it more and more the determining factor in naval victories.

Before the introduction of the shell gun, it was of very rare occurrence that ships were sunk, even in the most desperate encounters, and the amount of battering which was endured, and the small loss of life is surprising and almost incredible. In the battle of Soulshaie, June 7, 1672, the Lion d'Or engaged the Prince for 3½ hours, side by side, without any manœuvering, and keeping up a continual fire, yet out of 470 men on the Lion d'Or, not one was wounded. This sounds like a fable, but is stated by Gerard Brandt, a contemporary author, who says he had it on good authority. The custom of pointing high to disable and dismast, and a probable lack of appreciation of the elevation due to "line of metal" sighting, partially account for the small damage done. At Trafalgar, the Victory, in bearing down, received a few single shot at about ¾ of a mile from the French line, and, leading the weather column, presented a prominent mark to the enemy; as she slowly approached at a rate not exceeding a knot and a half, the firing increased, and when about 500 or 600 yards from the combined fleet, it is stated that 200 pieces of heavy artillery were playing upon her unanswered. In this manner 40 minutes elapsed between the firing of the first shot and the passage of the

Victory under the Bucentaur's stern, at which instant Nelson's battery opened fire, the first broadside being delivered when the ships were nearly touching and causing the Bucentaur to heel 2 or 3 strokes. The other English ships, ranging in wake of their leaders, received and returned entire discharges of the batteries in like manner. In this way for three hours was the contest maintained, and many cases occurred where single ships were exposed for a considerable while to the fire of several. Thus the Belleisle is said to have been assailed for at least an hour by three French ships,—the Achille, Aigle and Neptune. The conflict was almost a general mêlée, and in it were mingled 60 of the largest ships in the world, from one to four o'clock, delivering their broadsides at distances so short and marks so large that few shot ought to have missed,—and yet, not a single ship was sunk in the action, and but one went down in the gale that ensued about 36 hours afterwards. In the battle of June 1, 1794, Capt. Collingwood states in a letter to a friend that "the ship we were to engage was two ahead of the French admiral, so that we had to go through his fire and that of two ships next him and received all their broadsides two or three times before we fired a gun. We got very near and then began to fire. We left off in admirable good plight, having sustained less loss than could be expected, considering the fire we had so long on us. We had 9 men killed, and 22 with severe wounds; a few others slightly hurt; our masts, etc., all in their places, though much wounded,—and this, altogether, has been the hardest action that has been fought in our time, or perhaps ever. It did not last very severely much more than two hours."

The ships that fought in these and many other similar engagements were of wood, but their oak sides were a better defense against the guns of that day than is the heaviest armor afloat against the guns of to-day. With sides 32″ thick at the water-line, 31″ at the lower deck, 23″ at the main deck, and 18″ at the spar deck, the heaviest guns could only pierce them at close range. When we come to the War of 1812, we have only frigates and sloops engaged, and the improvements in powder and gunnery, together with the more equal offensive and defensive qualities of the ships, are apparent in the shorter time of action, the longer ranges employed, and the greater loss of life.

In the fight between the Constitution and the Guerrière, after 25

minutes' close action, the English frigate, dismasted, sinking, and a complete wreck, was compelled to surrender, with one-third of her men disabled,—15 killed and 63 wounded, against 14 killed and wounded on the Constitution.

In the fight between the United States and the Macedonian, close action did not begin till an hour after the firing commenced, and we have the evidence of the British court martial that "the Macedonian was very materially damaged before close action commenced." In this engagement the Macedonian had 36 killed and 68 wounded, against 7 killed and 6 wounded on the United States,—104 to 13.

The engagement between the Hornet and Peacock lasted only 15 minutes, when the latter was "literally cut to pieces," Lawrence says, and sank with 13 of her own and 3 of the Hornet's crew on board.

When we examine the naval engagements of our Civil War we find that the use of shell guns and the occasional use of rifles has greatly increased the destructive effect of gun-fire, except in some cases where armored ships fought against guns unequal to their penetration, as in the case of the Monitor and Merrimac. On January 31, 1863, the Mercedita, at anchor, was attacked by the Palmetto State, which suddenly appeared close aboard in a thick haze. A single shell from a rifled gun passing through the starboard side of the Mercedita, then through her steam drum and port boiler, and exploding against her port side, tearing a hole 4 or 5 feet square, caused her to surrender.

On March 8, 1862, the Merrimac destroyed the Congress by gun-fire alone.

On January 11, 1863, the Albemarle attacked the Hatteras and made her surrender in thirteen minutes. The Hatteras was riddled like a sieve, on fire in two places, and her engines and pumps disabled in 13 minutes, and she sank 10 minutes later.

On June 17, 1863, the engagement of the Weehawken and Atlanta took place, lasting only 15 minutes. During this 15 minutes the Weehawken fired five shots, of which four struck the Atlanta, the first one, a 15-inch shot fired at 300 yards, penetrating her armor and splintering the backing so as to injure 40 men.

On June 19, 1863, occurred the Kearsarge and Alabama fight, which is specially interesting as showing the effects of gun-fire in

an action between vessels built for war and of about equal power. The Alabama opened fire at one mile distance. Both ships had their batteries pivoted to starboard, the Alabama with 7 guns and the Kearsarge with five guns in action. The Kearsarge kept on at full speed, receiving a second and a third broadside, and when at 900 yards' range sheered and returned a broadside. After that they circled about a common center, making 7 complete revolutions, the Kearsarge always endeavoring to close and rake and the Alabama edging around, keeping her broadside bearing. In this way they gradually neared to 500 or 600 yards. During this time the sides of the Alabama were greatly torn by shells, and the crew of her after pivot had to be 4 times renewed. After an hour's engagement the Alabama was making water fast and steered for the shore, soon after surrendering, and 20 minutes later she sunk. The Kearsarge fired 173 (27 hits) and the Alabama 370 projectiles during the hour's fight, and the loss in killed and wounded was only 3 on the Kearsarge and 40 on the Alabama.

At the battle of Lissa, the Palestro, a wooden armored ship, was destroyed by gun-fire, being set on fire and blown up.

In the fight between the Huascar and the Cochrane and Blanco Encalada, the Cochrane opened fire at 3000 yards' range and one of her first shots penetrated the Huascar's side armor, and, exploding, entered the turret chamber, killed and wounded twelve men, set fire to the woodwork, and jammed the turret. During the action 80 men out of about 200 were killed or wounded on the Huascar, and twice her turret was pierced and both the gun's crews destroyed.

In the action of August, 1884, in the Min river, the French squadron, consisting of 1 second-class ironclad, 2 cruisers, 4 gunboats, and two torpedo-boats, attacked the Chinese squadron, consisting of 1 corvette, 8 gunboats, 2 transports and a dozen war junks. The French opened fire at 1.56 P. M., the torpedo-boats attacking under cover of the smoke. In 15 minutes, the fire having slackened and the smoke clearing, it was seen that the Chinese fleet was practically destroyed. The corvette had been sunk by a torpedo, three gunboats, dismasted and on fire from stem to stern, were drifting with the tide and soon sank some miles down the river, and another gunboat was seriously damaged, and sank while attempting to escape up the river. In less than half an hour

all that could be seen of the Chinese fleet was sunken vessels and hulks in flames.

The bombardment of Alexandria by the English fleet is often cited as showing the ineffectiveness of modern guns, but it is the effect of guns against ships that I am now speaking of, and that their effect to-day would be vastly greater than ever before seems to me undeniable. At Alexandria, short muzzle-loading rifles using studded projectiles with low velocities were in use, and guns and ammunition were perhaps inferior to any in use by any other naval power at that time. The shell tumbled in flight and frequently went end over end, the fuzes failed to act, and most of the projectiles were battering shot which did not explode at all. If a fleet armed with really modern guns were to repeat that bombardment, I do not doubt that the results would be far different.

But though the few instances I have cited tend to illustrate to some degree the increase in the destructive effect of guns, they do so far less than would be the case had we the experiences of an actual war between well equipped modern navies. Quick-firing guns, and smokeless powder, high velocities with consequent flat trajectories, armor-piercing shell, high explosive shell, efficient fuzes, electric firing, and all the other improvements which are but now reaching their perfect development, will render modern gunfire so terrible in its effects that only long range and armored protection will enable vessels to stand against each other for even a brief period. A ship which, either improperly armed or manned with men insufficiently trained in gun practice, trusts to her torpedoes or ram and endeavors by them to gain the victory, will fall an easy prey to an antagonist in whose construction and tactics the gun is recognized as the paramount weapon. Many will admit this as far as single ship actions go, but still are of opinion that fleet actions can be nothing but general mêlées in which the ram and torpedo will have full opportunity to do their deadly work. Against this opinion I will confine myself to quoting Admiral Coulomb, who says of the mêlée: "It is an abomination, a thing which no English officer ought ever to dream about or think about. The admiral who has his fleet in proper command will not have a mêlée; he will take care to keep his ships together, *coute qui coute*, and to withdraw for a time from the battle to reform rather than allow them to get into a mêlée where it is

impossible to say who is to win," and Capt. Mahan, who says: "The surer of himself an admiral is, the finer the tactical development of his fleet, the better his captains, the more reluctant must he necessarily be to enter into a mêlée with equal forces, in which all these advantages will be thrown away, chance reign supreme, and his fleet be placed on terms of equality with an assemblage of ships which have never before acted together."

And now, having given reasons for my belief that in the construction of ships of war and in their handling everything else should be made subordinate to the guns, let us consider by what means the maximum gun effect is to be attained with any given vessel, for, since the maximum force of a fleet is but the best combination of the forces of individual ships, the solution of the problem of getting the most effective navy will be found when we have determined what is the most powerful armament that can be put on each class of ship.

Now this problem may be resolved into two parts. (1) How many and what sort of guns should each class of ships carry; (2) How can those guns be fought most efficiently, and I shall take up these questions separately.

First, as to the number and kind of guns which any given vessel should be armed with. Speaking generally, the total displacement of every ship of war is taken up by three things: the weight of hull, hull protection and equipment; the weight for motive power; and the weight for the armament and its protection. The first of these may be considered constant for each class of ship; the problem is how best to divide the remainder. If we were to accept the solution of this problem which is given us in some of our own recent naval constructions, we might at once conclude that the rule is to fill each ship as full of machinery and coal as possible, and then, if there is any available displacement left, to put that into armament. But I do not accept this solution as correct. On the contrary, I think that in each class of ships a certain fixed percentage of the displacement should be allotted to the armament, and that everything else should be subordinate to this. It is of the *first* importance that a ship of war shall be able to exercise a full power of offense and defense within the circle of which she is the center. Secondary in importance to this comes the capacity of transferring that power from one point to another

with certainty and rapidity. It is very right that a vessel of war should have speed to overhaul an inferior or escape from a superior force, but the necessary diminution of her offensive power must not be so great as to disable her from matching *any* vessel of her own class having inferior locomotive power but provided with the proper armament, for this would render her unable to cope in battle with any but inferior rates of war-vessels; her usual business will therefore be running, and fighting will be the exception, a state of affairs rather incompatible with the notions commonly entertained of large and expensive vessels. It must often happen that in order to protect important interests the battle must be fought at all hazards and that avoiding action will not serve the purpose. What then will be the chances of costly fabrics like the Columbia, in which everything has been sacrificed to speed?

Moreover, if we are to sacrifice so much for speed, let us at least be sure of the possession of the whistle we pay so high for. Is not the speed we purchase so dearly in the smaller classes of vessels fictitious—not to be obtained under the conditions of real service?

That the armament of a ship should be in proportion to her tonnage seems to me so apparent that it should command universal assent, for it concerns the honor of the nation that its ships should always cope with an equal on not less than equal terms, and also it is a matter of financial interest that the force should be proportional to the cost of the vessel.

Now let us see what percentage of the displacement has been assigned in our modern ships to the armament and its protection, in which I include all guns with their mounts, ammunition, spare articles, and equipments, and all armor used to protect the guns. their crews, and their machinery, such as shields, armored sponsons, turrets, barbettes, and ammunition tubes. This percentage is as follows:

Petrel	8.3
Machias	8.6
Yorktown Class	7.7
Detroit "	9.3 (old battery.)
Boston and Atlanta	6.6

Charleston	6.6
Chicago	6.7
San Francisco	6.7
Baltimore	6.7
Olympia	7.7
Columbia and Minneapolis	4.2
New York	8.3
Indiana, Massachusetts and Oregon	25.3

and, considering the weight of the guns and their mountings alone, their percentages are reduced to the following:

Petrel	4.1
Machias	4.0
Yorktown Class	4.1
Detroit "	3.5
Boston and Atlanta	3.5
Charleston	3.0
Chicago	3.6
San Francisco	3.6
Baltimore	3.8
Olympia	1.9
Columbia and Minneapolis	1.4
New York	2.3
Indiana Class	6.8

Incredible as it may appear, the weight of battery of the Columbia and Minneapolis, of 7350 tons normal displacement, is no greater than that of the batteries formerly carried by the Constellation class, of 1200 tons displacement; and, moreover, the weight of metal discharged by a broadside of the latter vessel is considerably the greater. I will not attempt to lay down rules for determining the proper percentage of displacement to apply to armament, but it seems apparent that the above stated percentages are, in most cases, miserably insufficient.

The weight assigned to the battery being known, let us next consider how this weight should be distributed, and in this connection, the history of the old navies of sailing ships has the highest value for our instruction; for, the basis of their organiza-

tion was founded on the experience gained in actual warfare. Two fundamental principles guided the armament of these ships. The first, and most commonly adhered to, was the grouping of the greatest possible number of guns on all ships, of whatever class; the second, and later, principle was that of dividing the same weight of battery among a smaller number of the largest guns which could be readily handled at sea.

The argument in favor of the latter idea was well stated by Commodore Jeffers, as follows: "Many persons believe that a smaller caliber may, by celerity of fire and being more numerous for the same weight of battery, more than compensate for diminished accuracy and power. This is entirely fallacious. This argument is not new; it was offered by the English in 1812 for preferring the 18 to the 24-pdr., and has no better foundation now than then. I have found that with a well drilled crew the average time between fires is 43 seconds for the 9" smooth bore, and that this time is not reduced with the same crew and the 8" smooth bore. At the same time I may remark that every officer knows that the time required to load, fire and run out is never the standard for accurate practice; that is controlled on shipboard by the difficulty of pointing amidst the smoke and disturbed by the rolling and progressive motion of both ships. So that, as a general rule, under fair conditions, the rate of good firing may be two to three minutes. Rate of fire, therefore, will not effect the weight of metal thrown, but it will be influenced by another condition—the inferior accuracy of the inferior caliber. The 9", at 1200 yards, was found to strike 75 per cent. of the fires against 50 per cent with the 8". No effort, therefore, should be spared to use the heavier caliber, and wherever possible to go above the 9", I would advise it, but never below it. Therefore, in every case, the Bureau assigns the smallest number of the heaviest guns to form the assigned weight of battery, and prefers pivots to broadsides when the deck arrangements will permit."

Admiral Dahlgren, in advocating the use of the largest caliber practicable, says: "The misfortune of the larger caliber is that its substantial benefits are never visible before those who continually experience the disadvantage of its greater weight. The bulk of the gun, the toil in handling it, and its projectile, are ever enforced to the eye of the officer and to the exertions of the men. But the

great power which it does confer is not exhibited by the ordinary practice, and remains a myth until the hour of battle discloses the important fact, and permits the heavy caliber to tell its own tale more eloquently than the most labored advocacy. Fifty years ago the merits of the 24-pdr. were equally depreciated by the convenience of the 18-pdr. How rudely the delusion was dispelled may be inferred by the humiliating order of the Admiralty, issued after the loss of the Guerrière, Macedonian and Java, forbidding their 18-pdr. frigates to seek an engagement with the American 24-pdr. frigates."

This course of reasoning was sound, but new conditions have arisen within the past few years which should, I think, lead us to somewhat modify our conclusions. In the first place, the introduction of the rifled gun has greatly reduced the superiority of accuracy of large over small calibers. The 4" gun is now practically as accurate as the 13". In the second place, the power of guns has been so increased that the smallest gun is now a match for the unarmored parts of ships at the longest range. In the third place, the introduction of smokeless powders will greatly increase the importance of rapid firing. Finally, the use of fixed ammunition in comparatively large guns has greatly increased the celerity of fire of these guns. Consequently, I am of opinion that on unarmored ships, which must be armed with a view to opposing their equals, the advantages are no longer on the side of the larger calibers, but are rather on the side of the rapid-fire guns. On armored ships, on the other hand, where the guns must be suited to the attack of armor, the largest caliber practicable is still the best, for the destructive effect of projectiles increases rapidly with the caliber. Guns of such a size as to require machinery to handle them are absolutely necessary for use against heavily armored ships, and we lose nothing in rapidity of fire, while gaining greatly in effectiveness, by the use of the largest calibers instead of those of moderate size.

Another consideration, often disregarded, should have great weight in determining the batteries of ships. It is an axiom that the utmost simplicity is indispensable in all the arrangements of the battery, and the importance formerly attached to this was illustrated by the changes in the batteries of our own as well as the English and French ships about 1840, when the 32-pdr. was

substituted, at great expense, for all other calibers. Unity of caliber was then thought so desirable that even the superior power of the 42-pdrs. was sacrificed to it, and they, as well as the 18-pdrs. were displaced by 32-pdrs. To-day the importance of unity of caliber is less than formerly, owing to the less number of guns, and the practice of giving to each group of guns, or even to each gun, its separate line of ammunition supply; but when we learn that there are to-day in the English Navy twenty-six different patterns of guns, each requiring a different charge, and that five different calibers are frequently found on a single ship, we cannot but perceive the advantages of less diversity. For it must be remembered that unity of caliber carries with it the greatest possible simplification of all equipments, reduction in the number of spare parts, greater possibilities in the way of repair, and greater familiarity of the crew with the weapons they are to handle in action. But we cannot, of course, attain unity of caliber to-day, when the uses to which the guns of a ship must be applied are no longer as simple as they were of old. The heavy guns of the battleship would not avail to repel torpedo-boat attacks, nor are they necessary against unarmored structures, consequently other lighter guns must supplement them, and to a less degree this is the case on all ships.

Guided, then, by these considerations, let us fix upon the calibers which seem most suitable to the different classes of vessels which, roughly, we may take to be battleships, anmored cruisers and unarmored cruisers. Despatch and torpedo-vessels, having other functions more important than fighting with guns, I shall not consider. All other war ships, whether built for commerce destroying or not, should, I think, have batteries proportioned to their size, and of such a character as to enable them to meet on equal ground any ship of their own displacement.

The main battery of every battleship should consist of at least four guns of the largest caliber which she can carry consistently with a suitable second battery and properly proportioned armored protection. Although the 12″ gun will pierce any armor afloat with normal impact at fighting range, there is to-day on the proving ground armor which it cannot pierce at point blank—the side and barbette armor of the Indiana class will be a complete protection against the 12″ caliber—consequently this caliber is too small

for these ships. We have adopted the 13″ as our largest caliber; its muzzle energy is one-third greater than that of the 12″ gun, and it will probably be equal to any armor applied to ships, for the certain use of smokeless powder and the inevitable improvements in A. P. shell, will probably meet any further development of the processes of armor manufacture, and a further increase in thickness of armor is unlikely. We will, therefore, take the 13″ as the caliber which should constitute the main batteries of our largest battleships. The second and third-class battleships should have the 12″ caliber and the 10″ caliber respectively, for these guns are equal to piercing the armor of similar ships, and the reduction in the number of guns below four which would be necessary if we retained the 13″ caliber on the smaller battleships is undesirable. Next in importance to the four large guns constituting the main battery of each battleship, comes the second battery which is essential for protection against torpedo-boat attack, and which also may play an important part in action against other armored ships by being directed against the unarmored parts and the personnel. For this purpose we have adopted five different guns, the 6-pdr., 3-pdr. and 1-pdr. single barrel guns, and the 37 and 47-mm. rifled cannon, four of the five being placed sometimes on one ship. In recent ships, however, we have used only the 6 and 1-pdr.—a step in the right direction. The revolver cannon are much inferior to the single barrel guns and their use should be entirely given up. Of the other three guns, the rapidity of fire and ease of handling are not greatly different, and although the use of the 3-pdr. alone would have some advantages, still our present plan of abolishing this caliber and using the 6-pdr. and 1-pdr. guns only is perhaps the best, as the 1-pdr. can often be used in places where either the 3 or 6-pdrs. would be too heavy and occupy too much space. On many of the French battleships the 65-mm. or 9-pdr. R. F. gun forms a large part of the second battery, but I think that handiness is too much sacrificed to superior caliber in these guns, and I prefer the 6-pdr. Every battleship should carry as many 6 and 1-pdrs. as space can be found for. The weight of the greatest number for which emplacements can be found is insignificant beside that of the main battery; *e. g.*, the sixteen 6-pdrs. and ten 1-pdrs. of the Indiana class, with their ammunition and outfit weigh but 80 tons out of the 1100 tons of the entire battery, and

each gun adds appreciably to the power of the ship. Our ships as a rule carry too few of these guns.

But besides the main and secondary batteries, there is considerable displacement available on the larger battle-ships for other guns, and what these should be is a question which has received many answers. The French battleships of recent design usually carry a number of the larger R. F. guns; *e. g.*, the Lazare Carnot has eight 14-cm., the Marceau seventeen 14-cm., and the Masséna eight 14-cm. and eight 10-cm. R. F. guns. The English Barfleur carries ten 4.7-in. and the Royal Sovereign class ten 6" R. F. guns. Our own Indiana class have eight 8" and four 6" guns.

I think the extended use of thin armor in the armored ships now being built justifies our position in this matter. The eight 8" guns of the Indiana are equal to the penetration of the heaviest armor of many armored ships and will be very effective against all but the heaviest armor of the largest battleships. This caliber is the largest which can be conveniently worked entirely by hand, and whenever, as in second and third-class battleships, there is not sufficient displacement to allow its use, I would advocate going at once to the 5" gun for this part of the armament. The 6" gun, being too large to admit of the convenient use of fixed ammunition, should have no place in the batteries of our ships hereafter.

For the main batteries of the unarmored classes of war ships, I advocate R. F. guns alone. With smokeless powder in use, rapidity of fire will have full play, and the four 5" R. F. guns, which can be substituted for one 8" gun, will deliver at least four times the weight of metal with practically equal accuracy. The 6" gun, with a very expert crew, may perhaps fire one well-aimed round per minute, the 5" R. F. gun should fire certainly two, and perhaps three. If the present San Francisco, with her twelve 6" guns were opposed by a similar ship with twenty 5" R. F. guns, an equal weight, would not the odds be in favor of the latter's victory? Against unarmored ships, and under the conditions which will prevail in the near future, the number of guns and their rate of fire are more important than their individual power. Consequently the main batteries of the larger unarmored ships should consist of as many 5" R. F. guns as they can carry, and the main batteries of the smaller ships of as many 4" R. F. guns as they can carry. The secondary batteries of unarmored ships

should be made upon the same plan as those of battleships—each ship should carry as many 6-pdr. or 1-pdr. guns as space can be found for.

Armored cruisers, being of very considerable displacement, in order to combine great speed with reasonable armored protection, must be armed with a view to engaging not only cruisers, but, on occasion, battleships of the smaller classes. Consequently armor-piercing guns must constitute a portion of their batteries, and the 8″ caliber is peculiarly adapted to this use, having sufficient power for efficient use against even the most modern armor up to 10 inches in thickness, and at the same time being capable of working entirely by hand. At least four, and if possible six or even eight, of these guns should be carried by every armored cruiser. The rest of the main battery should be similar to that of unarmored cruisers, namely, the largest number of 5″ rapid-fire guns which can be properly placed, the 4″ R. F. gun being used if the displacement available for battery is not sufficient to allow a considerable number of 5″ guns to be carried. The secondary battery should, of course, be of the same character as for all other ships.

Having fixed upon the calibers of guns to be used, the next question is as to the power of these guns. Should they all be long, high power guns, or should we use shorter and lighter guns so as to have more of them for the same weight? The advantages of high power are greater penetration of armor and greater flatness of trajectory, of which the first is only important in the larger guns while the second is of great value in all cases. We gain these advantages in two ways, by using large powder charges, and by adding to the length of our guns; have we gone too far, or not far enough in these two directions? The guns in common use all over the world to-day use powder charges of about half the weight of their projectiles and are from 30 to 40 and even 45 calibers length of bore. To increase the velocity by increasing the size of the chamber and using a larger powder charge, would be very undesirable, and is not likely to be done because the adoption of smokeless powders will give a far greater increase of velocity with the present chambers than can be gained in any other way. To add to the present length of guns is to add but slightly to their velocity, and even less with smokeless than with the brown powders, and, moreover, this would add to at least as

great an extent to the weight of the guns besides detracting from their handiness. Altogether I think that 40 calibers is about the extreme length of bore desirable and even the advantages of this length over 30 or 35 caliber guns are doubtful. I regard it as certain, however, that there will be no backward step, the increased danger space of high powered guns will not be sacrificed to the possibility of mounting more guns on a given displacement. The real difficulty is to find emplacements for the guns which a proper disposition of weights will permit ships to carry. (Harveyized armor requires high power. If we abandon heavy guns, complete protection can be gained.)

The next question to consider is the best disposition of the guns which are assigned to each class of ships. All heavy guns should be mounted in pairs, in turrets, and if possible on the middle line, so as to be used on either side with equal facility, a pivot gun is practically two guns, and turret guns are the modern substitute for the pivot guns of older types of ship. The plan, often used by the French, of mounting 4 single guns in turrets, one ahead, one astern, and on each side, has only apparent advantages. It would appear that by this means equal weight of fire was obtained at all angles, 3 guns on each bearing, but actually there is loss of efficiency, for on the bow and quarter bearings but two guns are available, and on no bearing are more than three in action, while with pairs of guns on the middle line we have four guns on each broadside and two on every bearing. Besides, this is a very uneconomical arrangement, the protection of a single gun being almost as heavy as would be required for a pair of guns.

Whenever possible, the guns should be mounted in pairs, in turrets, on the middle line. When there are numerous small guns, this plan is, of course, no longer feasible, and in such cases guns should be mounted in broadside on covered decks, or, at least, under the cover of bridges and superstructures. They should *never* be enclosed in compartments, each separate from the others, but should be mounted as far as possible on one deck, open fore and aft, like the gun decks of the old wooden ships. To enclose a gun as those of the Columbia are enclosed, in small compartments, is to insure the destruction of the crew and the putting of the gun out of action by the first shell which enters the compartment. The absence of bulkheads, and above all of

wooden sheathed bulkheads, is of the utmost importance, and a clear deck is as essential to efficiency to-day as it ever was. In former times all necessary bulkheads were made removable and when the ship was cleared for action they were taken down. Long experience had shown the terrible effects of splinters, and every possible precaution was taken to prevent them as well as the risk of fire.

Moreover, a clear deck is necessary to complete control of the battery and this is even more essential to-day, with rapid-fire guns, than it used to be. The objection to a clear battery deck is the supposed effect of a bursting shell sweeping the deck fore and aft, but this seems to me ill founded. Unarmored ships should, as far as possible, be fought broadside on, not only so as to deliver their most effective fire, but also because in this way they are best protected against gun-fire. In this position, percussion shell, the only ones of any value, passing through the thin side plating, will not burst until they have traveled from six to ten feet, and thus cannot injure men on the engaged side except those almost directly in the path of the shell. No splinters are produced by the perforation of the side, unless it be sheathed, and as all men on deck should be on the engaged side the damage done by the exploding shell will be a minimum.

Of coure, if ramming tactics are employed by the enemy, it becomes necessary as he closes to either meet him bows on or to run away, using quarter fire. This disposition on the part of an adversary, when it becomes apparent, will therefore force the assumption of a position with the enemy on bow or quarter so that his shell will enter at an angle of 30° to 40° with the keel, and consequently tend to sweep the gun deck fore and aft with their fragments. This attack, however, may easily be met by the use of splinter bulkheads, or partial transverse bulkheads between the guns and extending inboard sufficient to shield each gun from the fragments of a shell entering just forward or abaft it. In this way, the advantages of a clear deck and complete control of battery are not sacrificed.

I have said that guns should, if possible, be mounted under cover. The reason for this is the ever increasing efficiency of machine gun fire. It seems to me that with well served machine guns of the modern small caliber in an enemy's tops, the crews of exposed guns could not live at 1000 yards or even greater range.

Invisibility is one of the greatest of protections, and even the lightest deck or other covering will, I believe, be of great service. There is something, however, to be said in favor of open deck batteries. In the first place, I believe that men will fight better in the open than when closed in, though there may not be much in this idea. In the second place, and this is important, the smoke and fumes of bursting shell will more quickly dissipate on open than on covered decks.

The secondary battery guns should be distributed as far as possible all over the ship, but should not be allowed to interfere in any way with the placing of the main battery, being generally mounted above the latter, on bridges and superstructures. In some large ships, it may be possible to mount these guns below the main battery guns as well as above them, and this would be very advantageous in repelling torpedo-boat attacks. The grouping of these guns, so as to give combined action and control of fire, is not important as it is with the main battery guns.

For the military tops I believe in machine guns only. A pair of small caliber machine guns, with a motor attachment for running at high speed, or even worked by hand, can deliver a stream or bullets almost like the water out of a hose and with fair accuracy even up to 2000 yards' range. Moreover, these bullets will perforate the sides of light vessels at short range, and so will be very effective against torpedo-boats. Their destructive effect on the personnel, if they are used to the extent that they should be, will be very great in future naval engagements.

To sum up the foregoing remarks, I would lay down the following propositions as a guide to the determination of the batteries of ships :

(1) The whole object of a man-of-war is to fight, and whatever detracts from her fighting power should be remedied or removed. The battery constitutes the main fighting power of every ship, and all other things should be made subordinate to its efficiency.

(2) The grouping of the maximum number of guns on each should be the principal idea in the armament of modern ships as it was for those of former times, due regard being paid, however, to the necessity for sufficient power in the main battery guns of armored ships to penetrate the armor of probable adversaries.

(3) Power lies in broadside far more than in end-on fire.

(4) Control of gun-fire is of great importance, both to avoid waste of ammunition and to prevent injuring friends in actions where several ships are engaged.

(5) It is of great importance to so place guns as to avoid the fragments caused by shot striking neighboring structures, and, above all, not to enclose them with wooden or sheathed bulkheads.

(6) Unless rapidity of fire is greatly inferior, the larger caliber should be preferred, whenever displacement permits its use in reasonable numbers.

(7) Diversity of armament should be avoided as far as consistent with the probable uses of the battery.

And now, having fixed upon the batteries of our ships, we come to the important, but little studied, subject of how to use them, and as a preliminary to the few remarks which I have to make on this subject, let me quote to you the words of Comdr. Morris as to the causes of our naval successes in the War of 1812: "The remote cause, as it appeared to me, was to be found in the confidence of our enemy, and in our distrust of ourselves to contend successfully against them; in the neglect of careful exercise which resulted from the enemy's confidence, and, on our part, in the unwearied attention of our officers to devise and bring into daily exercise every improvement which might increase the chances of success against a navy to which we might soon be opposed as an enemy. . . . *But* the great source of our success was *undoubtedly* the superior *management* and *direction* of our guns; and that the English and other governments were satisfied of this is sufficiently evident by the careful attention they have since continued to give to this branch of the naval service."

Observe that he says "the *management* and *direction* of our guns!" The very idea of managing and directing the guns of a ship so as to greatly increase their efficiency is, I fear, a strange one to most officers of our navy to-day. No attention whatever appears to be paid by any one to this subject, and one would judge by the general indifference that there was no longer anything to do with the guns in action but to let the gun crews fire them at will.

The offensive power of a ship's artillery depends on three things only: the speed of the ship, the character of the battery, and the

method of using the battery. Other things being equal, speed enables a ship to engage when and as she elects, to place herself near or far off, within or without the field of her adversary's fire. Other things being equal, the battery composed of the greatest number, of the largest, of the most powerful, or of the most accurate guns has the advantage. But it is the method of using the battery which weighs most in the balance, and it is upon this element that we must depend for *decisive* advantages.

Speed is an affair of the design and construction of the ship; the character of the battery is a matter of design and of regulation; the *use* of the battery is in the hands of the officers of the ship themselves, and it is to their discredit if any effort is spared to bring this element to the same plane of efficiency as the other two. I shall not now speak of the instruction and training of the men in the use of the guns, though the importance of constant exercise and drill, directed *always* to produce the most efficient use of the guns under the circumstances of actual battle, cannot be exaggerated. It is the subject of methods or systems of fire to which I wish to direct attention. Have we any systems of fire in our navy? I fear not. And yet it cannot but be that under the various circumstances of naval engagements there are various systems of fire, of more or less efficiency. At close range, and with the view constantly obscured by smoke, it would be absurd to use the guns in the same way as at long range. With guns which take three minutes to load it would be absurd to open fire under circumstances which justify the use of rapid-fire guns. How, then, shall we use our guns? In the first place, it is essential that the manœuvres of the ship shall be directed to facilitate the effective action of the battery, and to this end the captain should have effective, and not merely nominal, control of the guns of his ship. This requires proper grouping of the guns and a system of transmitting orders clearly and rapidly. Voice tubes, or better, electric dial indicators, should transmit the ranges, kind of fire, and other necessary directions from a central station to the officer of each gun division. The officers and men at the guns cannot properly estimate the distance of the target or the correctness of their aim, and they should not be allowed to alter the setting of the sight bars except by order from the commanding officer or whatever officer may be assigned to the duty of regulating the fire of the battery.

An efficient range finder would add to the accuracy of gun-fire, but the greatest help to effective fire will be the constancy of range or its slow variation, which should be sought by skillful manœuvring. With a uniform or slowly varying range, the fire of a battery can be controlled and directed so as to give a large percentage of hits even at extreme range. Without any system of control and direction the best trained guns' crews will fail to deliver an effective fire.

If smokeless powder were in use in guns of all calibers, the problem would be greatly simplified, for then firing at will, under proper control as regards rapidity of fire and corrections of elevation, would be best in almost all cases. But with our present powder, an attempt to fire at will, except at close range, or under special circumstances, would result in such confusion and obscuration of the target as to greatly reduce the efficiency of the fire.

The following is a brief description and discussion of the various systems of fire which may be used under different circumstances:

1. *Concentrated Broadside Fire.*—The guns are laid so as to converge upon a point at a given distance upon a given bearing, and are fired *simultaneously* when the enemy reaches that point. This method, much used formerly, has fallen into disuse on account of the character of the batteries of modern ships. It appears to have many advantages for use at close range or in passing an enemy, permitting the captain to deliver his entire weight of shot at a single blow and at the most effective moment. With broadside batteries of rapid-fire guns, such as I advocate for unarmored ships, this method of firing has no place, but with heavy guns in pairs in turrets it may be used in a partial way to advantage. Each pair of turret guns should be fitted for simultaneous firing by the gun captain in the sighting-hood above them. The turret should be trained by another man on the turret floor, whose whole business should be to keep the guns pointing at the target all the time, and there should be marks indicating angles of train. Except at long range, simultaneous firing of each pair of guns should be used for the reason that this will cause less loss of time from smoke, and at times, as when about to pass close to an enemy, it may, and probably will, be desirable to lay all the turrets on a given line of bearing and reserve fire till all the guns bear together. In such cases, of course, the angle of train selected should be such as

to deliver the shot as nearly as possible at right angles to the enemy's armor, if armor is being attacked. An attempt to fire all the guns from a central station, will, however, require electrical connections, more or less complicated and very liable to be cut or otherwise injured, and the firing will, I think, be as nearly simultaneous as necessary if each pair is fired by its own captain when it bears. For such firing the guns should be laid horizontal, as it can only be used effectively at such short range and under such circumstances that errors in elevation due to roll are immaterial.

2. *Concentrated Fire at Will.*—This system of fire can be used effectively only with rapid-fire guns. Its object is the delivery of a great volume of fire for short intervals of time when at comparatively short range and when the smoke prevents accurate pointing by the gun captains themselves. The guns are laid on a given line of bearing, elevated for the given range by the use of the sights, and at the signal are fired as rapidly as possible without change of train or elevation, the ship being, of course, so manœuvred during the interval of firing as to keep the bearing of the enemy unchanged. Even in case of considerable rolling of the ship this method can be used effectively if, by practice, the gun captains have learned to regulate their rate of firing to agree approximately with the period of the ship, so that each round is fired at about the same phases of the roll. The following instance of an attempt at rapid firing at will is given by Admiral Dahlgren: "On one occasion the Cumberland, Commodore Smith, was at general quarters and had placed a target at about 600 yards to windward, the sea was smooth and the breeze light. After some leisure firing an order was sent from the quarter-deck to fire as rapidly as possible for fifteen minutes. The number fired in that time averaged about seven rounds per gun on the main deck, though a few of the guns went as high as eight rounds. The crew of the frigate was one of the best trained (not merely in the form) that I remember to have seen. So embarassing was the smoke that there is little doubt that, even with the interval of two minutes, more than half the shot were fired upon the general direction which the target was supposed to have." What, then, is the use of rapid-fire guns, if some system be not devised to enable us to profit by their peculiar excellence, rapidity of fire? Imagine the case of the San Francisco, with a battery of twenty 5″ R. F. guns, about to

engage with another unarmored ship. At a given moment the captain estimates that within so many seconds his adversary will bear at such an angle and be at such a distance, the proper signal causes each gun on the engaged side to be laid upon the stated line of bearing at the stated elevation, and as the guns bear, the signal is given, "commence firing." For say thirty seconds, by the proper helm, the bearing is kept as nearly unchanged as possible, and then the signal is given "cease firing," and a new line of bearing and range are given. By the time the smoke has cleared the guns will be again ready and fire is again opened for thirty seconds, and so on. In this way at least five rounds per gun can be delivered with very fair accuracy of pointing, during each interval of thirty seconds, while if the guns are fired continuously at will, the gun captains may be unable to get a glimpse of the target more than once in a minute or even two minutes. This system of fire, tested on a large scale in the French Navy some thirty years ago, and called "Tir précipité" was then found very effective.

3. *Successive Firing.*—This system of fire has great advantages at long range, both because by firing successively from forward or aft, as the case may be; the interference of smoke can be prevented, and above all because the accuracy of the fire can be increased by observation of the points of fall. The firing interval, of course, depends largely upon the character of the guns employed, but it may, in the case of rapid-fire guns, be desirable to specify it, lest too rapid a fire annul the advantages sought by the use of the system. In using this method, it is important that the sight bars be adjusted only as directed by the officer on deck who regulates the fire, and a system of signals, by bugle, drum or whistle, should be established, whereby orders may be given to correct the elevation. For example, the distance being estimated at 4000 yards and and the ship steaming at high speed, or with the wind strong from ahead, the order would be given "fire in succession, from forward, 4000 yards." As soon as pointed, the forward gun fires and as their sights bear the other guns fire in succession, with the same sight-bar setting. The officer whose duty it is to regulate the fire from a suitable position on deck, observes the points of fall, and from time to time, without causing any slackening of the fire, corrects the elevation by signals which indicate "move the sight-bars up so much" or "down so much," as the case may be.

4. *Firing at Will.*—This, which would be the most effective system of fire under almost all circumstances, if the target and the point of fall of their shell were visible to the gun captains or divisional officers, will become the most important method of firing only when smokeless powders are in common use in all guns. At present it should only be used under such circumstances that the smoke clears rapidly and the range is known accurately, and is either nearly constant or changes very slowly. Firing at will is, however, almost necessarily used for the secondary battery guns, and consequently it is of the utmost importance to have these guns supplied with smokeless powder, so that they can be used without interfering with the more important rôle of the main battery.

A very important question, especially with regard to heavy guns, is at what range should they open fire. Some years ago it was generally thought that it would be advisable to reserve the fire of the main battery guns of battleships until close range, from 300 to 500 yards, was reached, but this opinion was based on the idea that such ships would engage in a series of mad rushes at and by each other. To-day I find the use of long range fire advocated by most recent writers. For myself, generally speaking, I consider that it would be folly for the captain of a ship to miss any chance, however small, of disabling his adversary, unless he thereby sacrifices other *superior* advantages. Of course, if the enemy is approaching, and you are forced to meet and pass by him, you must not lose the chance of close range fire for the sake of the smaller chance of disabling him at long range. All, in such a case, depends on how long it takes to reload the guns. If approaching at twenty knots, and it takes less than three minutes to reload and point, then I would open fire at 4000 yards, knowing I could again fire at 2000 yards, and yet be prepared for the most advantageous position when abreast of my adversary. But if it takes four minutes to reload, it would be throwing away chances to open at 4000 yards. Consequently, the importance of knowing the time of reloading heavy guns and reducing this time to a minimum by frequent exercise, is very great.

In case the engagement is one in which both sides seek an artillery duel, and consequently steer so as to remain at a distance, I

believe that fire should be opened with the main battery guns at at least 4000 yards. It is a mistake to seek to save ammunition at the risk of losing your ship, and the fire of modern guns may, with proper skill, be made so effective at 4000 yards range as to practically decide a battle at that distance. The secondary battery fire should, as a rule, be reserved until the range has been reduced to about 2000 yards, but may be used at greater ranges when smokeless powder is in use.

And now, in closing, let me repeat to you the words of a distinguished French naval officer who wrote a good many years ago, but whose words are as true to-day as ever :

"The gun is everything. Upon its employ should be concentrated all the attention, all the intelligence, all the activity, and all the energy of the navy. To have efficient guns, good systems of fire, every auxiliary which will assure accuracy and increase rapidity of fire, and to combine the service of the battery, well practiced and prepared for emergencies, with the movements of the ship, offers an immense field, unhappily ill explored, to the activity of a squadron."

"It is not by the invention of special projectiles and of powerful guns of exceptional range and accuracy that superiority is attained. Everything lies in the use which one makes of these. Material imitation is easy; what one invents to-day, his neighbor has to-morrow. That which is really difficult to imitate is patience, persevering efforts applied to the instruction of the crews, the aptitude which comes of habitual practice, and the harmony established between commanding officers, the manœuvres of their ships and the service of their batteries."

"These are the bases of a real and lasting superiority; these are the only advances whose foundations can be laid by naval officers and whose realization they can directly seek."

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ANCIENT NAVAL WARFARE.

By LUIGI FINCATI, Rear-Admiral, Italian Navy.

(Translated by the late Medical Director Philip Lansdale, U. S. N., with the collaboration of Lieutenant Albert Gleaves, U. S. N.)

CONTRIBUTED BY REAR-ADMIRAL S. B. LUCE, U. S. NAVY.

INTRODUCTION.

The following translation of a monograph on the naval tactics of the trireme period, by Admiral Fincati, well known for his researches as a naval archæologist, cannot fail to prove interesting, if not instructive, to the student of naval history.

The fact that the *rostra*, or beak, of the trireme imposed upon the fleets of antiquity a certain system of tactics, in which ramming was a cardinal point, invests the study of this period of naval history with an interest it had completely lost during the time when ships were fought under sail, and ramming was impossible.

In the former, the effective use of the principal weapon of offense, the beak, necessitated such a formation of the line of battle as would bring that weapon most readily into play. In the latter, the conditions of wind and sails, and the artillery in broadside, were equally imperative in their requirements of a system which would give all the advantages to the gun. In the former, the ram called for the *line abreast*; in the latter, the gun necessitated the *column* as the normal formation for battle.

Admiral Fincati's article brings prominently in view two very important factors of a sea fight, which were common to both periods of naval history: The destruction of the adversary's motive power—the wrecking of the oars of the trireme; the shooting away of the spars and rigging of the sailing ship; and the practice of carrying an enemy's ship by boarding.

With the return of the beak, as a weapon of offense; with guns no longer restricted to the broadside, but rather having a practically full circle

of fire; with the motive power screened, and yet not wholly inaccessible; with boarding still practicable under possible contingencies; and with the destructive agency of the torpedo added, it is for the naval tactician of the day to determine just how far, and in what direction, these conditions will control the organization of a modern fleet, and its disposition for battle. The opinion is expressed in the body of the paper that, in respect to these matters, we have something to learn from a study of the naval wars of the ancients; and one can hardly read this article without arriving at the same conclusion.

S. B. LUCE.

I.

The naval warfare of the ancients may be considered, like that of modern times, under two heads, the Preparation and the Conflict.

War having been decided upon, the admiral would collect his ships and organize his fleet. Before putting to sea he would appoint a rendezvous as near as possible to the enemy, where the *impedimenta* of the ships could be landed before bringing on an engagement, to the end that he could make the attack with the vessels lightened, an important consideration in the days of oars, when every inch of draft increased their unhandiness. It was thus that Lutazio won his victory when he surprised the enemy heavy with stores and hampered with rigging. Under the same circumstances Polisenedes hastened his attack upon the Romans, and Annone, the Carthaginian admiral, landed his spars, masts, etc., at Erice, after the manner of a gladiator who throws his doublet upon the ground, before crossing swords with his adversary.

The ships being thus cleared for action, it was necessary to wait for a favorable condition of sea and wind. The fleets of Cæsar and Anthony lay in sight of each other for four days before engaging, waiting for the sea to go down.

The admiral had also to decide where he would fight. If he preferred the open sea, he would try to get the enemy between himself and the shore, so as to crowd him on the beach and leave him no room to get headway or to make an assault, an advantage to be kept for himself. "I will not fight in a gulf, nor in it will I cruise," said Formione, "since it is apparent that a narrow space is not suitable even for a few, well manned ships engaging heavy, badly managed vessels. It is not possible to fall upon the enemy and ram him in an effective manner, except from a good distance and

ahead. Neither is it possible to properly defend one's self when crowded in a narrow space where there is no room to strike the enemy amidships, and then turn at once and ram him from astern."

Calvesius forgot this maxim and narrowly escaped defeat in consequence. "At daybreak," says Appiano, "the Calvisians were almost touching the shore with their ships at the bottom of the gulf, drawn up in a crescent (*mezza luna*) with their prows fronting seaward. Menecrates appeared in sight of the gulf, pushed forward his ships and fell upon the Calvisians, crowding them against the shore which was close astern of them. Calvesius resisted bravely, but he was so hemmed in that he could not move his ships, while those of Menecrates hauled off and returned, each delivering his blow and relieving the other in turn. The Calvisians, however, could neither retreat nor attack."

The same thing happened to the Romans when fighting against Aderbale. Polybius gives the following description of this battle: "The ships being at length liberated with much labor, the captains drew them up in line of battle along the coast, with their bows pointing seaward. The consul, who first followed astern of the fleet, then advanced and placed himself on the left wing. Meanwhile Aderbale, with five ships, fell upon the left wing of the Romans, who thus found themselves between the enemy and the shore. Both sides advanced to the conflict in line of battle, and the pretorian ships, having hoisted their ensigns, began the attack. The battle raged furiously on both sides, the flower of the armies of both countries being on board the ships. For a time the issue of the battle seemed uncertain; but the Carthaginians finally gained ground, not only because their ships were lighter and the rowers more expert, but *especially*, because, having sea room they could manœuvre freely, and withdraw to chase any of the Roman ships that might become separated, and run them ashore. If any Carthaginian ship was in danger, her consorts could easily succor her, through the facility of manœuvring afforded by the sea room astern of them; while the Romans, on the other hand, were constantly embarrassed by being so far in shore that they could neither withdraw nor assist each other; nor, which is more important, break through the enemy's line and assail him astern or in flank."

The notable battle of Salamis offers an example of a maxim

opposed to that just stated. Here Themistocles preferred to fight in the Straits of Salamis, because a great portion of the Persian fleet could be rendered inactive and excluded from the battle altogether, owing to the impossibility of forming the line of battle in such a narrow channel.

Great care had to be observed in avoiding places subject to strong currents, which always rendered evolutions difficult and uncertain, especially for one of the combatants.

The loss of 70 ships of Nicanore was due to the contrariety of the currents. Referring to Aderbale's experience with adverse currents, T. Livius says: "The motion of the sea impeded the steering of the ships, nor was the combat equal, because, on the part of the Carthaginians, neither art nor prudence availed; the arbiter of the fight was the sea which forced its current between the contending ships, while they tried in vain to resist its influence."

Careful attention was also paid to the direction and force of the wind, in the hope that it would not be adverse on the day of battle. Vegezius observes that a good opportunity of engaging is offered when the enemy has the wind against him, and Bomilcar, in Livy, "feared to engage, not from being of inferior force, but because the wind favored the Roman fleet more than his own."

Having noted these considerations, which had more or less an indirect bearing upon the battle, we will now proceed to discuss those that concerned it more intimately.

First of all, the sails were lowered, the masts more or less inclined, the oars got ready and the arms and implements of warfare placed at hand. The ships of the Liburni, says Vegezius, "struck their enemy with the beak, not by force of sails but of oars, and at the same time skilfully avoided his blows." Livy relates that Polisenedes, "hearing of the approach of the Roman ships under sail, moved at once with serene front to meet them, upon which the Romans lowered their sails, inclined the masts and got ready their arms." And Irzius says, "suddenly it happened that against him came a ship laden with warriors with yards at half mast; upon which he quickly braced up his yards and armed his crew for the fight." "The gallant Carthaginians, seeing the way closed by the Romans," says Polybius, "furled their sails and, encouraging one another with loud shouts, threw themselves into the conflict."

Annone with great skill availed himself of his sails to escape from an overwhelming force of Syracusians. Finding himself confronted by the numerous ships which Dionysius had sent out against him, he clewed up his sails as if about to fight; the enemy did the same, and while the latter was arming and getting ready for action, Annone quickly made sail again and fled.

II.

Before describing the sea fight, it will be necessary to give some account of the tactics. Naval tactics then, as now, were of the highest importance, for upon the battle formation depended in a great measure the result of the engagement. The formation varied according to circumstances.

The formation of the Roman fleet corresponded with that of the army, that is, it consisted of four parallel lines or squadrons called "classes," disposed in column. The first line was known as the "prima acies," or "prima classis," the second and third lines were numbered accordingly, while the fourth was called the "triarii," as in the army. Later the name of "subsidiariae" was given to all ships not in the first line, which, being the strongest, constituted the line of battle proper, and retained its name of "prima classis."

Our authority for this is Irzius, from whom we also learn that the theory of the "group" or "peleton" was known to the ancients.

"Cæsar turned his fleet within the light-houses, and forming his line confronted the Alexandrians; he placed the Rhodian ships on the right, the 'pointed ones' on the left, and kept the reserves (*subsidiariae*) in the rear, with orders to support the first lines. The Alexandrians at once assumed the same order with 22 ships in the first line."

The term *subsidiary* was not vague or indefinite. The subsidiary (auxiliary) ships were in effect to reinforce those in advance of them; all had their stations assigned and their movements prearranged. If our Ré d'Italia had had a "subsidiaria" astern of her, the Kaiser Max would have been sent to the bottom, or else she would not have attempted the stroke that cost us so dear.

Sometimes there were added a third line of lighter ships, the *veliti*, which, unlike the *veliti* (or skirmishers) of the army, did

not skirmish with the enemy, but accompanied the fleet and held themselves ready to take any part that might be assigned them, thus constituting, as it were, a reserve to the reserves.

Sometimes they preceded the fleet as scouts. It was then their duty to molest the enemy by cries and menaces, and annoy him by showers of burning arrows.

When Attalus fought Philip, he distributed these little vessels among his fleet, but became so entangled with them that he lost the battle. Timothy, on the other hand, put them in the first line and pushed them forward among the enemy, driving in his skirmishers and demoralizing his fleet. Then advancing with his fresh and hitherto unengaged line, he succeeded in winning a complete victory.

When the fleet was formed in single line, as often happened, the best and strongest ships were placed in the wings and the weaker ones in the center. This order was observed at Salamis. The Spartans and Athenians were collected upon the left wing, confronting the Phœnicians; the Megareans, which were, as says Diodorus, the narrator, the most formidable at sea, took post on the right wing; in the center were posted all the other Greeks.

Similar dispositions were made in the fleets of Cæsar and Anthony, and Vegezius, in his Military Institutes, directs that at the extremities of the front line shall be collected the flower of the ships as well as of the fighting men. The commander-in-chief should place himself in his flagship, at the head of the right wing; but if the formation be semi-lunar he should post himself in the center.

"If thou shouldst form in crescent, oh, Captain-General (says the Emperor Leo, in his tactics), place thy dignity in the exact middle of the arc, to the end that thou may'st see everything, order everything, govern everything, and lend assistance wherever it may be needed."

In any case and with every tactical formation, the captain-general, contrary to the rule laid down in armies, should always occupy the most conspicuous post of his fleet. Conon availed himself of this invariable rule to deceive the enemy. Having heard from a prisoner that his adversary intended concentrating every effort against himself personally, he placed his flagship on the right of the line and then took his position in another ship on the left.

The battle formation which the Greeks called *skema taxcos* (σχημα τάξεως) was either usual or occasional. The crescent form was much used, because in it the ships were disposed in an uninterrupted series so as to form in the center a concavity, or bay, from which the extremities were projected like arms or horns. In this curved line the ships mutually presented their flanks with all their prows pointed toward the opening of the arc, and steered a course parallel to the sine of the arc, up to the moment of converging towards the enemy and enfolding him in their midst, as if in a huge embrace. This order was called by the Latins *lunata* and by the Greeks μηνοειδέα.

It will be seen by these examples that the lunar form served to encompass and confine the enemy, and to overwhelm him if he tried to break through the center, so that, entangled by this manœuvre within a semicircle, he presented necessarily his flanks to the beaks of both wings, which, to wound him effectually, had only to make a half turn and strike him in the flank. (See Fig. 1.)

In line abreast (a straight line), the ships were disposed side by side, like a squadron of horse ; this might be single, double or triple. It was single when the line was continuous, double when the line was separated by an interval, dividing it into two squadrons. When the line was separated into three squadrons it was triple and formed then a battle-corps in the center, with two wings on the sides, all in line abreast, like the three battalions of a regiment. The post of the commander-in-chief was always on the extreme right. (Figs. 2, 3, 4.)

If the three squadrons, instead of being in line abreast, were disposed as "column of squadrons," the formation was called the *phalanx*, and in this all the ships would be subsidiary to those which preceded them, as already explained. (Fig. 5.)

These were the principal formations, but there were others in occasional use, namely, the pinchers (*forceps*), the wedge (*cunaeus*), the oval (*ovalis*) and the convex (*incurvae* or *falcata*).

The forceps order presented, as Vegezius explains, the form of the letter V, in which the ships formed the two arms, with their prows pointing from the point. This order was a modification of the lunar or crescent order, in which two straight lines were substituted for the curves which composed the second. (See Fig. 6.)

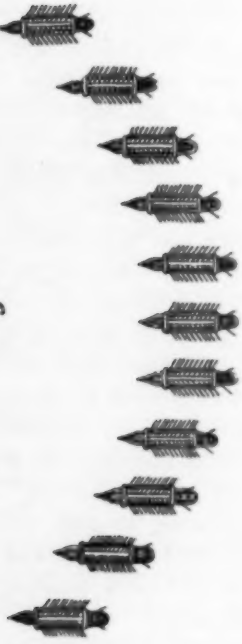

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5

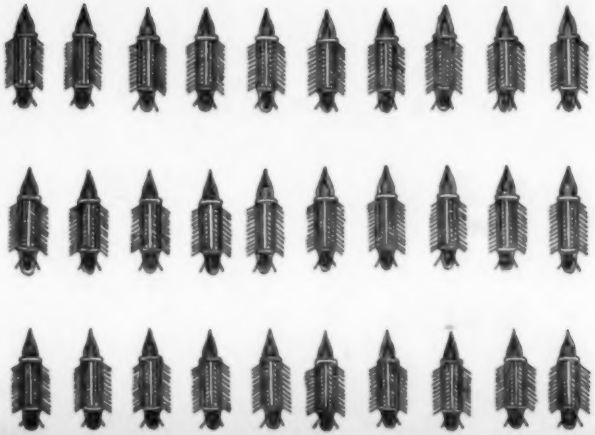

Fig. 6

Fig. 7

The wedge order was the reverse of the last, having the form of the letter A, in which the ships were disposed in two lines, as in the forceps, but having their prows toward the apex. It was essentially a formation for attack, or for chase, and transformed itself into the other order, by simply reversing the course. The Romans were accustomed, sometimes, to add to this formation a third line of ships, disposed between the two wings, thus completing the form of a triangle, in which the bows of all the ships were pointed towards the advanced angle, the course being at right angles to the third line. In this order, as in the preceding, the ships were admirably subsidiary (auxiliary) to each other. (Fig. 7.)

In the circular, or oval, formation, the ships were arranged in a circle, more or less large, and like radii, or the spokes of a wheel, their sterns were towards the center, and their bows pointed to the circumference. (Fig. 8.)

Polemius called this formation the κύκλον, "cyclon" (circle) and describes it very minutely. He says, "when the Carthaginians sighted the great fleet of Dionysius, they disposed their ships in a circle, with the triremes in the centre. The ships of the outer line were crowded with soldiers to resist the first assault of the enemy. During the engagement, and at the proper moment, the triremes were to rush out through the intervals between the ships and attack the disabled vessels of the enemy and sink them."

The advantage of this formation consisted in the defense of each ship on the flank, and in keeping bows on to the enemy in every direction. It was considered the best defense against a foe superior in numbers.

The employment of this formation was not always successful. Thucydides, relating the naval battle between the Peloponnesians and the Athenians, says that the former "arranged their ships in a circle as large as possible, without, however, leaving the intervals wide enough to permit the enemy to pass through; a convoy of light barks were placed in the center together with five of the fastest ships which were held in readiness to reinforce the point of attack.

"The Athenians approaching in single column (line ahead) swept around the circle, almost touching it, and threatening every moment to assault, thus forcing it to contract. But Formione, the Athenian admiral, had given orders not to attack without signal,

Fig. 8

Fig. 9

believing that the enemy would lose his formation and his vessels foul each other and the convoy. Should the prevailing easterly wind blow out of the gulf, the confusion would be greatly increased. In this event, he could assail them with his fast ships at pleasure. (See Fig. 8.) What he anticipated actually happened; it came on to blow, and the ships already crowded in a small circle, collided with each other and with the barks. So that, with the cries of the sailors, in their mutual efforts to avoid collision and injury, orders were no longer heard, the voices of the 'regulators' were lost in the terrific din, and the men being unaccustomed to use their oars in rough water, the ships became unmanageable and no longer answered the helm. At this juncture, Formione hoisted the signal for action; at the first attack, the Athenians sunk one of the divisional flagships (*navi capitane*). The Peloponnesians were thrown into a panic: they cast away their arms and fled in confusion towards Patræ and Dyme, in Achaia.

"The Athenians pursued them, captured ten of their ships, and having made prisoners of nearly every one on board, sailed for Molicrius, where they erected a trophy at Rhium; dedicated a ship to Neptune, and then headed for Naupactus."—(Thucydides, Book II.)

The convex form, called by the Latins "falcata" (sickle-shaped) and by the Greeks χύρτη, was the reverse of the lunar, already described; in the latter the horns, or arms, are thrown forward; in the former to the rear, with the center in advance. Thus the lunar was a modification of the forceps; and the convex a modification of the wedge, in both cases the right line being changed to a curve. (Fig. 9.)

These formations were sometimes reinforced either upon the wings, the center, or the flanks. In fact they differed but little from military manœuvres, which at that period was natural and rational, and often necessary. This similarity between the movements of the fleet and the army was not materially varied, except when the use of the oars restricted the interval in which a ship could be effectively handled to less than two-thirds of the circumference of a circle.

The crews of the vessels were assigned stations according to their duties, their arms and their individual merit. On the *catastromata* or forecastle, in the turrets, or *rambate*, were stationed the

warriors clothed in heavy armor, kneeling down behind their shields; behind them were those whose duty it was to manage the war catapults, fire tubes, etc. Then came the archers and slingers, who wore no armor and who kept themselves behind the defenses. The pilots were at the helm and the rowers at their oars, with arms extended, all waiting for the signal of battle.

III.

Besides these dispositions and preparations, the fight was still further preceded by ceremonies intended to exert a moral influence upon the combatants. The first was the seeking of auguries which, when favorable, were immediately made public.

Augustus, passing along the coast of Actium, before engaging in battle, met an ass with its driver; which, unfortunately for Anthony, were named respectively Nikon and Euticus, meaning victory and good-luck. The augury could not have been more happy nor more explicit. Not so, however, the sneeze heard afar in the army of Timotheus, nor the thunder-bolt which fell upon the army of Cabria, which conveyed sinister prognostics.

Referring to these incidents, Frontinus remarks that skilful commanders were extremely cautious how they dipped into the future, and took good care that the interpretations were favorable to their enterprises. Sacrifices and votive offerings were next in order. The sacrifice was always performed by the commander-in-chief, with his head veiled in the skirt of his garment. "While Themistocles stood sacrificing on the poop of his flagship, there were brought before him three young prisoners, beautiful in form, covered with splendid vestments, and wearing gold ornaments. They said they were the sons of Autaretes and the king's sister. At that moment, the seer Euriantes, who had seen a flame of great brightness arise from the victim he had just immolated, and had heard a sneeze on his right side, clasped the hand of Themistocles and commanded that these youths should sacrifice at once a victim to Bacchus Omestes, after which safety and victory would be assured to the Greeks."

Besides the sacrifices the commander-in-chief also made votive offerings, which were first proclaimed by the "celeuste," or singer, who, in a loud and clear voice, promised to the gods, altars, tem-

ples and other gifts, if they only would vouchsafe to them the victory.

The "exhortation" was made on the eve of the conflict. The ceremony was performed by the admiral alone, who, in a swift dispatch-boat, ran under the sterns of his ships and delivered a stirring address, a salute, or an admonition to each one of his captains. "Nicia, admiral of the Athenians, seeing his fleet prepared for battle," or, as was said by the Romans in phrase equally technical but more beautiful and energetic, *in procinctu esse*, and mindful of the great crisis, leaped into a dispatch-boat and rowed among the triremi; with hands outstretched, he called the captains by name, conjuring them in the name of the gods to vie with each other in valor, and thus crown that hope which alone remained to them."

The fleet, *in procincto*, awaited the signal for action.

Signals were made with a purple flag, hoisted on the most elevated portion of the flagship (*nave pretoria*). They were few, simple, and clear, and sufficient for all the necessities of an engagement. No ship was permitted to signal the flagship. Such signals were considered inopportune, and indicative either of weakness or excessive prudence. "In your flagships," orders the Emperor Leo, "let every signal be in a conspicuous place, whether flag, banner or what not, that you may make known to all what is necessary to be done, to assault, or withdraw from the fight; to turn the enemy so as to attack in flank, or astern; to render assistance where it may be needed; to increase or decrease speed; to lay an ambush or escape from one, etc."

"All this will be easily understood by every one who watches the signal attentively, whether it be held upright, or inclined to the right or left, whether it is waved alternately from side to side, or up and down, whether it be taken away entirely, or exchanged for another of different form or color, as was the custom with the ancients, who made use of a red cap elevated on the point of a long pike."

"Signals should be frequently exercised with, so that all your captains may have a thorough knowledge of them, and understand them perfectly; so that when well accustomed to the use of them they may be quick to comprehend the orders they are intended to convey, and to obey them without hesitation."

Sometimes they made the signal for battle with a gilt shield—in fact, Plutarch mentions this as the usual signal. The moment this signal was made, the trumpet of the flagship sounded the "classicum" (called by the Greeks the "polemikon," and in our day "the general"), which was repeated from all the ships of the fleet.

To the blare of the trumpet was added the ringing voices of the warriors, until the very sea resounded with the din of preparation, and the echoes repeated it from the neighboring shore. "Innumerable voices mingled in the air, and the clamor of the cries drowned the sound of the oars." (Lucanus, lib. III., 540–41.)

IV.

Having thus noted the incidents that preceded the conflict, we have now reached the point where "the beaks take up the argument."

According to the school histories the naval warfare of the ancients consisted of a grand hand-to-hand struggle, with the single idea of boarding each other's ships, and throwing at each other stones, arrows, burning poles, boiling oil, brambles, melted lead, and even pots of serpents and scorpions!

The writer remembers that when a boy at school a professor on one occasion, giving the class an account of an ancient sea fight, became so excited that he jumped on a chair, turned back his cuffs and shouted like a sailor, and when he had finished sat down, perspiring and exhausted, but satisfied that he had lectured not only on ancient history, but also upon the art and science of war.

Such graphic displays kindled our boyish admiration for the prowess of the ancients, but inspired the belief that their courage and strength counted for everything, and there was nothing to be learned from their encounters; in short, that they were ignorant of the scientific principles of war, and that with them the race was always to the swift and the battle to the strong.

Nothing could be more erroneous. From the moment the golden shield shone out from the flagship and the trumpet sounded the "classicum," the combat was fought, with lessons which have been imitated by the great captains of modern times.

First of all note that, contrary to the customs prevailing in the army, the commander-in-chief was the first to advance with his

flagship. Plutarch does not leave this in doubt. "Hardly," says he, "was the fight commenced by the ship of Attilus than all the other ships moved suddenly without awaiting any further signal." And Diodorus Siculus, describing the battle of Salamis, says, "The captain, preceding all others, was the first in the fight." The main object of the captains and pilots was to go into action ship against ship, with a view to break the oars or the rudder of the enemy, or to ram and strike him, taking care, however, to avoid a like fate themselves. Although ramming was a difficult manœuvre, it was preferred by skilful captains, who held boarding in light esteem. Ramming required handy but strong ships, skilful helmsmen, numerous and expert rowers, and captains with hearts of bronze and eyes of the lynx; in a word, it required naval superiority of the highest order.

The Rhodians, who proved themselves excellent sailors in their wars with the Macedonians and excelled them in martial attainments, avoided hand-to-hand fights, but repeatedly used the ram. This was naval warfare, pure and simple, and was often compared by the writers of the day, in their finest descriptions, to cavalry charges, as we read in Florias. . . . "The Roman fleet was active, nimble and light, resembling a battalion of cavalry; the oars acting as spur and curb, ready to dash; now upon this side, now upon that, having the appearance of a living animal." Fighting hand-to-hand was not commended. Of this method Thucydides says in his description of the battle between the Corciresi and the Corinthians, "the battle was furious, but resembled more a land fight than a naval engagement, in that, having been brought to close quarters, they threw themselves upon each other and fought hand to hand. None of the ships attempted to break the enemy's line and attack in the rear, but all fought with the fury of courage and strength rather than with science, so that the action presented a scene of disorder and confusion."

It is clear how, under some circumstances, the most skilfully planned battle would degenerate into a fierce mêlée, the issue of which would depend more upon personal gallantry and strength of arm than skill in the art of maritime war. This art was called by Lucan "*artem pelagi*," and consisted chiefly of skilful rowing, bursting upon the enemy under full headway, and tearing or flanking his vessels, and pursuing detached ships. Their battle

tactics commenced by *feeling* the enemy—that is, in approaching him—then suddenly withdrawing and manœuvring in sight of him. Polybius, speaking of Hannibal's attack, says: "He provoked the enemy to fight by manœuvring about him; now dashing forward, now making a masterly turn, now stopping short, as mounted troops are fond of doing with their horses." With these and other offensive movements he sought to deceive and fatigue him until a favorable opportunity offered to spring forward, dash against him and sink him, breaking through his line and assailing him in the rear by a sudden turn, or turning and taking him in flank. This charge was repeated again and again, until the enemy's line was broken in one or more places, through which a passage could be effected to his rear. Then turning quickly he might succeed in striking the adversary in the stern; and if the enemy had imitated this manœuvre the two lines would again find themselves confronting each other, bow to bow, as in the beginning of the action, having simply inverted their respective positions. In the "circumvolution" the ships doubled the enemy's line and took him in reverse or pursued him, each party endeavoring to crush the oars of the adversary by rushing upon him at full speed. As Livy says, "two of the royal ships attacked one of the enemy's on both sides and cut off all his oars."

The combatants also tried to ram each other; as the weakest part of a ship was the beam, every effort was concentrated to strike right amidships. On the other hand the defense exerted all their skill in trying to receive the blow on the bow, or at least as obliquely as possible. There are a great many examples of ramming, proving that it was considered the principal and most natural form of attack.

"The Peloponnesians dashed forward to ram the enemy's ship, but the latter with singular skill kept their bows constantly end on, and so only received glancing blows."

"Four Rhodian ships issued from the gulf and were attacked by the Alexandrians, who stood on to meet them. The Rhodians resisted, and handled their ships with such skill, that, although inferior in numbers, their adversaries could neither strike them in flank nor cut down their oars, for they kept their bows always presented to the attack." (Irzius in the Alexandrian wars.)

Occasionally the beam of a ship was presented to the enemy.

This manœuvre may have sometimes occurred as a result of inattention on the part of the pilot or of confusion of orders, and thus led to most disastrous consequences, but ordinarily it was done with the deliberate purpose of receiving the thrust, and then making fast to the adversary at the moment of his striking, as we learn by the example of the Illyrian ships, each one of which, having lashed on each side of it another vessel to serve as a shield, allowed the enemy to strike on the beam. The vessels which acted as buffers were, of course, crushed by the enemy's beak, but the attacking ship was immediately seized and made fast, when the warriors accumulated on the triple decks of the three lashed together, boarded and took possession of the assailant. This species of stratagem was resorted to by slow and heavy ships, which could not manœuvre with quickness and dexterity. They fortified themselves in the manner described, and by the sacrifice of the defense vessels obtained an easy victory. Thus did Brutus, saying to his pilot: . . . "*palerisne acies errare profundo?*" etc., (Lucan, lib. III, v. 559.) This expedient was practicable only when, through the great strength of the ship itself, or by making use of others as bulwarks, there was no fear of the enemy's beak. In all other cases the blow in the flank was fatal and to be avoided if possible. In the fleet of Mindarus "seeing that the enemy was so formed as to offer his flank to the attack, each one began anxiously to fear for his own safety." (Diodorus, lib. XIII.) *So with us at Lissa!*

In the fight between Cæsar and Anthony, described by Plutarch in his life of the latter, both antagonists refrained from ramming; the ships of Anthony were too slow and Cæsar's ships were too light to risk contact with Anthony's, which he knew were reinforced with wood and iron. A blow upon the bows was much less damaging than one upon the flank, from the greater strength of that portion of the hull, but on this very account, and from the fact that the two ships then met at full speed, the shock was so violent that many were sometimes knocked overboard from the forecastle. Appianus says, "Then the ships rushed at each other, striking either in flank or astern, or on the bows, this last being the blow that, more than any other, staggered the combatants and brought up the ships suddenly, causing them to gather stern board, and if this did not occur from the shock, those which

had had the best of the encounter hastened to draw off, backing on their oars, either to keep the enemy from making fast, or to prevent the water from entering the breach made by the beak. Livy wonders and notes it as an unheard of thing that, in a combat between the Romans and the Tarantini, no one seemed to care to withdraw from the enemy after having wounded him with the beak.

A ram blow in the stern was particularly dangerous on account of the rudder, and it was also difficult to accomplish, owing to the possibility of the vessel rammed returning the blow by one amidships.

Ramming was adopted by the Syracusans, after Aristones had advised them to make the bow shorter and lower the position of the beak or ram, like the Corinthians at the battle of Erineus. "In this way, "says Thucydides, "the Syracusans hoped to defeat the Athenians, who were unaccustomed to practice such hazardous manœuvres."

These tactics resolved the fight into so many duels, each ship endeavoring to lay herself alongside one of the enemy. The fight, however, began at arrow-range, so to speak, with stones, javelins, arrows and weighted darts discharged by hand, or from suitable machines, aim being particularly directed at the helmsmen, the pilots and the captains. When the fleets closed, the ships grappled, the quickest crew boarding with a cheer (*barrito*, the cry of an elephant), and the fight was ended by a bloody carnage with lances, swords and two-edged battle axes. The engagement thus assumed the appearance of a fight on shore, "*terrestria praelia miscent*," because the style of fighting and the arms were those incident to the attack of a fort. Even the famous bridge of Duilio was very much like the bridge which was lowered from the movable tower when assaulting the walls of a besieged city.

"Now ceases the throwing of darts, nor do the soldiers fall pierced from afar. The encounter is hand-to-hand; from his own ship each stands within reach of the blows of his adversary, and the sword finishes the fight." (Lucan, lib. III, v. 567.)

The invasion of a double barbarism, physical and moral, which led to the disappearance of the high state of civilization of Greece and Rome, and which for three centuries we have been endeavoring to restore, destroyed both the civil and military order. Brute

force invaded the field of science and art; and battles, by sea and land, scientifically conducted by the great captains of Rome and Greece, became disorderly struggles (mêlées), in which ferocity was the only criterion of success.

Vegezius, in the 4th century, and the Emperor Leo the Wise, "in the 9th, embodied in one system all the military art of the ancients; but their labors remained a dead letter until the great age of the *Renaisance*, in which, with philosophy and the arts, civil and military science began to revive.

Up to the middle of the 16th century the ships of war of the Mediterranean did not differ from those of the ancients, except in their ornamental and accessory parts. The form, capacity, armament and oars of the Venetian and Genoese triremes were like those of Athens, Syracuse and Rome. For this reason the order of battle and the method of fighting were counterparts of those so clearly and exactly described by Thucydides, Polybius, Titus, Livius and others. This is clear from what is recounted by Nabal Conti in his "History of My Times"; by Bartolomus Crecenz in "Nauta Mediterranea"; by Christopher da Canale in his "Dialogues on Naval Affairs;" and, especially, by the very learned Captain Pantero Pantera, who, in his "Armata Navale," illustrates all his laws and maxims with examples drawn from the naval engagements of the ancients.

"The fleet," says the captain of the Santa Lucia, should be divided into four squadrons—the advance guard, the line, the rear guard and the reserve. Let the admiral choose a few fast galleys to cruise ahead of the fleet as scouts, exploring the neighboring coasts and gathering news of the movements and intentions of the enemy. He will select officers for the command of his squadrons and assign their stations in the order of battle, so that each one, knowing his position, will not interfere with the movements of the others. At sea the distance between the squadrons shall not be less than 1600 metres.

"Each squadron shall have its own distinguishing standard, and every galley or other vessel attached to a squadron shall fly, in a conspicuous place, a standard conforming to that of its own squadron.

"The Fleet of the League (1571) had distinguishing standards of different colors; the advance guard flew a green standard, the centre blue, the rear guard yellow, and the reserve white."

Captain Pantera recommends only two of the Greek and Roman fleet formations; the order of line abreast for sailing ships and the semicircular or crescent (*di mezza lune*) for those propelled by oars, reinforced at the centre and the wings, as was adopted by the great fleet of the League which triumphed at Lepanto. "Some would have it," says Captain Pantera, "that the galleys should maintain such a distance apart, only, as would afford room to row without collision. Others maintain that the interval should be such as to allow each galley to manœuvre, *i. e.* to turn and change front without interfering with the others. This distance would be larger than the former; hence, others are of the opinion that, when on the eve of an engagement, the galleys should not be so widely separated, lest the enemy pass through the intervals and attack in flank or astern." He adds, "where the intervals are wide a confusion of the order of battle is likely to occur, and if the fleet be numerous, covering a wide extent of sea, the extremities would be too far separated to lend mutual aid in case of necessity. For this reason, others advise that the galleys be kept an oar's length apart, *i. e.* far enough to avoid fouling each other's oars."

"The position of the admiral or general in his royal galley is in the center of the line. The extremities or horns of the line, as well as the van and rear of each squadron, should be in command of officers of high rank and acknowledged ability.

"The reserve squadron (*la squadra del soccorso*) should be composed of the fastest and best galleys, and in command of an excellent captain, *who will know where succor is most needed and* HOW TO AFFORD IT IN AN ORDERLY AND EFFICIENT MANNER.

"This squadron must be stationed well astern of the line of battle, whence it can move quickly, and without loss of time, to any point where assistance is most urgently needed.

"In order that each squadron may manœuvre freely and without interfering with the others, there should be left a sufficient interval between the line of battle (centre) and each horn (wings).

"In addition to the reserve squadron there should be assigned to each divisional commander two well equipped galleys ready to assist, if necessary, their chief. Their positions should be astern of the divisional flagship. (See Fig. 10.) If *galeasses* are attached to the fleet they should be posted about a mile ahead when the fleet is in line of battle."

Fig. 10

It is worthy of note that Captain Pantera does not refer to ramming or other manœuvres of that kind. It appears, therefore, that the "*artem pelagi*" of the doughty captains of antiquity had been forgotten, or that their successors no longer dared to practice it.

VI.

From the foregoing it appears that the ancient ships were weakened amidships and strongest in the bows. Each one was armed with a ram, and carried in the bows the catapults and the bronze tubes which were used for throwing Greek fire. These tubes were the prototype of the 30-pounder guns, four of which at a later period were mounted in broadside.

From Salamis to Lepanto, a period of twenty centuries, the ships of war, *par excellence*, were always triremes. Their dimensions did not vary materially from a standard which is described in detail by Cristoforo da Canale, who gives the following dimensions: length, 120 feet; breadth, 16 feet; depth, 6 feet; displacement, about 150 tons. The sides of the ship in the wake of the oars were strengthened by two layers of timber, one placed fore and aft, the other vertically. Besides taking the strain of the oars, this additional thickness was a defense for the rammers, and served to deaden the blow of a ram. These timbers formed a kind of casing which at a little distance looked somewhat like enormous ears, and had some resemblance to the paddle boxes of our side-wheel steamers. A fighting deck was built in the bows; this was called the "catastromata," and has already been referred to.

The crew consisted of 200 men, of which 150 were rowers and the remainder were soldiers or fighting men. The rowers were arranged three by three on twenty-five benches, on each side of a midship passage-way. The longest oars were about 32 feet (Venetian measurement) long and each was pulled by the man farthest in board. The middle was 30 feet long, and the outboard oar was about a foot shorter. The oars, therefore, projected in groups of threes.

The greatest speed of a trireme was about 6 or 7 knots per hour; on a voyage, however, it could not make more than 4 knots the first hour, and from 2½ to 1½ knots afterwards, for in a short time the rowers became exhausted and had to be relieved. The dis-

tinguished Admiral Jurien de la Gravière denies the possibility of the arrangement of rowers as described above: he says, "*et vous Gênes et Venise ne compliquez pas la question; vous n'avez jamais essayé de faire asseoir sur une seule planche trois rameurs, ayant chacun en main, un aviron; votre banc n'est qu'une façon de parler; il n'indique pas un siége, il indique un espace.*"

About the middle of the 16th century "sweeps" were introduced, and the thwarts, which for the oars had been placed obliquely to the keel, were placed at right angles to it, and one oar was assigned to each thwart, but each oar was pulled by three, four, or five men, and sometimes even by as many as eight. The larger ships pulled thirty oars. These monstrosities, however, had a short life, for their utility proved inferior to the hopes of the designers of the period. Their number was limited to one, two, perhaps three in a fleet, the other vessels being rowed by three men to each oar.

The glorious trireme closed its long and brilliant history with the splendid victory of Lepanto. Thenceforth, for two centuries, the laurels of the sea were to be won by immense line-of-battle ships propelled by the wind and armed with heavy artillery. When the galley period ended the era of sails began, and this new condition forced new tactics and new methods of naval warfare.

Rome, 1879.

[*Note.*—It is interesting to note in this paper the prototypes of latter day methods of clearing ship for action, the call to general quarters, wig-wag and other signals, ramming tactics and battle formations. There is nothing new under the sun. It was largely due to violation of Formione's maxim that the Chinese lost the battle of the Yalu.—A. G.]

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

AN EXAMINATION OF THE TESTIMONY TAKEN BY THE JOINT COMMITTEE OF THE SENATE AND HOUSE OF REPRESENTATIVES IN REGARD TO THE REORGANIZATION OF THE NAVY.

By Lieutenant W. L. Rodgers, U. S. Navy.

The navy has been much interested in the proceedings of the joint committee of the two houses of Congress to consider the reorganization of the navy. Although the testimony there taken has been published, it is so voluminous, there is so much repetition, so much is trivial or deals with undisputed matters of fact well known to every naval officer, there is such a lack of continuity in the arguments, one witness supplementing and completing those of another, that it will perhaps prove instructive as well as interesting to assemble the arguments and make a connected summary and comparison of the various proposals advanced.

Let us first consider the proposals relating to the line: In general, it may be said of the proposals that they are divided into two classes, those which are intended to increase the efficiency of the navy and those which are intended merely to disarm opposition within the navy to the vital measures.

After examining the drafts of bills submitted and the arguments on them, it appears that all propositions made embrace only a few main features, and the bills differ in their modification and combination of these features. It will be unnecessary, therefore, to consider the details of bills, for the general principles of all plans of reorganization are covered by a few proposals.

Necessity for Change.—The first point to consider is in regard to

the necessity for any change (p. iii). In favor of the change, it is urged:

1 (pp. 3, 14, 29). That the present system brings officers to command rank at too great an age, when they have passed the period of the greatest efficiency, and when they cannot remain long enough in the upper grades to make an adequate return for their high retired pay.

2 (p. 50). It is necessary that those in the upper grades should be of greater average ability than those in the grades below them (p. 31). It is false economy to give commands to inferior men.

3 (p. 68). The present system is bad in having only a *pass* examination for promotion, for the Board always decides any doubt in favor of the individual then before it, instead of in favor of service efficiency (p. 19). Poor officers thus feel that they can float along until retired with high pay, for (pp. 17, 18, 68) the Board is unwilling to dismiss for professional fault. Some system is desirable that will substitute a healthy competition for promotion among officers (pp. 38-145).

It will be admitted by all that, among the plans which fulfil these objects, that is best which has the least objections in administration, and will cause least friction and be least liable to abuse.

On the other hand, those who are opposed to change say that the present organization gives results that compare very favorably with other services, for "the present U. S. Navy system of promotion by examination is really selection of the fittest; it is not necessary to look to foreign navies to break the block in promotion on a list where every man is a picked man" (p. 277), and that changes should be moderate, for "the younger men in the Navy may wish all impediments to their advancement removed; but it should be remembered that something is due to those who have grown gray in the service of their country."

It is also said (p. 72) that the present stagnation is merely a temporary one, which will be removed when the large classes of the war reach the retiring age.

The Unfitness of Officers to Decide on Necessary Changes.—On coming to examine the changes proposed, we find it admitted by all that the efficiency of the service should be considered above all things; but in their statements the Secretary of the Navy and

others point out (pp. 19–26) that any measure looking to the improvement of the service will be opposed by those officers who are professionally or otherwise below the mark.

On examination of the drafts of bills submitted to the Committee, and of the statements in regard to them, it appears clearly throughout the whole that while officers are the only persons who can give valuable testimony as to the actual condition of matters in the Navy, they are far from being the proper people to draft remedial legislation; for underlying the greater part of the statements before the Committee is the tacit assumption that not only each officer's present commission and retiring pension, but also the prospects of future promotion, are vested rights of individual officers. In fact, it was frequently assumed that whatever changes might be adopted, no man's expectations should be materially worse under the schemes proposed than under the present law. It is evident that such an assumption contravenes the avowed object of the Committee, and it is surprising that its members seem to have respected it. Indeed, it is probable that no witness was anxious to point out the weight of this assumption upon the the deductions drawn, so that the Committee's attention was not directed toward duly considering the claims of the government as against the interest of its employees.

Another point in this connection is that it is difficult to the most honest man impartially to consider proposals which affect himself.

The Principles of the Proposed Changes.—If, in the various plans proposed, we neglect the question of pay as not being one of organization, and certain minor features as being independent of any general plan, we find only seven important principles, whose combination and modification vary according to the predilection of individuals.

These proposals are:

1. An increase in the numbers of officers in the upper grades.
2. The establishment of a reserved list for certain specified shore duties only.
3. A specified amount of sea service to qualify for promotion.
4. Retirement at varying ages, according to the rank.
5. A considerable and immediate reduction in the numbers of those classes which entered during and just after the war.

6. Promotion of meritorious officers by selection from those having certain established qualifications.

7. The provision of a fixed number of vacancies in each grade each year, by the removal from the active list of the necessary number of least valuable officers.

Arguments Regarding the Proposals.—In deciding, as each must do for himself, upon the relative advantages of these proposals, we must all bear in mind the three points previously mentioned, which, as the testimony shows, call for remedy in the present condition of the service, namely, youth in the upper grades, superior average ability in the upper grades, and competition throughout; and further, we must decide how far those proposals which perhaps do not conduce to efficiency in the Navy are necessary concessions for the sake of disarming opposition, and obtaining more essential matters. Lastly, we must consider whether any change provides for a permanent basis in the future.

1. *Increase in the Upper Grades.*—The Secretary of the Navy argues in favor of more officers in the upper grades on the ground that it will diminish the age of reaching command rank, and that in other services the proportion of commanding officers to those below them is larger than it is with our Navy, and that more experience in command is necessary. It is also said (p. 43) that it is not reasonable to expect the older officers to go to sea as much as younger ones, as they are entitled to rest, and also (p. 53) that if the list of captains is long, the Secretary has a large body to choose from, when looking for a good man for special work. On the other hand, it is shown (pp. 53, 59, 97) that holding a commission only cannot make a man fit to command; experience is necessary, and as long as Congress does not increase the number of ships, an increase in command rank cannot give any increased experience at sea, but rather the contrary.

On the whole, therefore, it seems that the efficiency of the service would not be raised by an increase of commanding officers, unless it is admitted that some of them on the active list should never be permitted to go to sea; so that the proposal is not one of fundamental importance, but a makeshift which is sure to please all.

2. *Reserved List.*—Next we take up the reserved list. It is proposed to establish a list of officers who will not go to sea, but will

perform certain shore duties only. It will be recruited preferably by volunteers, but compulsorily if necessary. Promotion as high as captain will be given on this list, and it is affirmed that it will be as distinguished a list as the sea-going one.

The object of introducing this list is to place people in command at sea while still young, and to shelve those officers least fit for sea duties while retaining their services. Whatever the Department may assert as to its intentions, it is impossible that such a list will enjoy the prestige of the sea-going list. Still it must not be regarded as a dishonorable list, for in any rational scheme of promotion there must be some way of indicating preferences among individuals, but no one can be disgraced by such expression of preference. As for giving a man promotion after it has been decided that it is inadvisable to send him to sea, that certainly is merely a measure for preventing opposition from those who may fear being placed on the reserve list; and of inducing others, both good and bad, voluntarily to make way for juniors, while offering to Congress a plausible appearance of economy.

It is proper here to consider the views of those officers who maintain that a change in law which unfavorably affects a part of the list is unjust and an interference with vested rights. There is no legal basis for such a contention. If there were, there could be no legislation on any subject, for every change in law works to somebody's disadvantage.

A man's prospects are no more his rights in the navy than in civil life, and the proposal of the Secretary to give officers promotion on the reserved list was most liberal, and entirely for the sake of diminishing the hardships of necessary reform. If the country is to continue to maintain a navy, it should be established on a thoroughly sound basis, with none but the best officers in the upper grades. In discussing the changes necessary to this end, navy people naturally wish for no impairment of their prospects or personal positions, but the whole weight of evidence taken by the committee shows that efficiency calls for radical changes, and it should be remembered that the longer Congress considers the matter the more generous will appear the proposals now offered to ease the fall of the weaker competitors.

Sea Service Qualifications Required for Promotion.—The third proposal is to establish a sea service qualification in each grade as a necessary requisite for promotion.

This qualification is called for in other navies (p. 165), and is a proper one, because an officer can be formed and developed only by such service. Nevertheless, in each grade the time required must be moderate in reference to the ratio of ships in commission and number of officers in the grade, because if it is unduly great it throws the choice of officers for promotion directly into the hands of the Department, without any of the restrictions which should guard such a practice.

Age Limit to Service in Different Grades.—The age limit in grades is meant to bring officers to the upper grades early enough in life, and is the simplest possible measure to accomplish the object. It is advocated as an independent and sufficient measure by those who say that it is improper to make distinctions between officers whose record is without reproach, and who believe that if the navy is to be rejuvenated it should be by a method which casts no discredit on those struck from the list for the advantage of the service. Such an argument disregards the fact that to make a change valuable it should not only bring young officers in the upper grades, but also admit only superior people to high rank, and should make every man work in competition with others to earn promotion. It is evident that between any persons occupying about the same place on the list, personal differences in health or abilities are far more important than two or three years of age; and, in the interest of the government, these differences should be made the criterion, and not age. Thus, although age retirement as the sole measure of reform commends itself to many persons, because it conveys no reproach; yet, from the government's point of view, this is a poor way for making its decision among the men of any class date. It has no more relation to their present and future capabilities for efficient service than would any chance method of choice, such as throwing dice.

Immediate Reduction in the War Classes.—A fifth proposal is the immediate reduction in the classes entering during and just after the war.

The object is to reduce the classes to a normal size, so that the classes below will not be kept out of command rank until close upon retirement (pp. 4, 5).

Another reason advanced is that these classes have not been properly scrutinized before graduation or since (p. 173).

Another reason for the reduction of the "hump" is that if any change whatever is to be made in the system of promotion, it is necessary to prepare a permanent basis by a transitional measure which shall at once raise the average ability of the upper grades to the desired permanent standard, while decreasing the average age. This can be done only by a careful scrutiny of the upper grades, and the removal of those least fit for service. Against the proposal that the scrutiny should now be extended to the lower grades, it may be said that the measure is simply transitional, and that the turn of the present junior officers to be weeded out will arrive in due time as their duties change with increasing rank.

6. *Selection for Promotion*; 7. *Selection for Retirement.*—The two plans of selection for promotion and selection for retirement have some common features, and if wisely administered should produce similar results; it will, therefore, be convenient to consider them by comparison with each other. Both plans contemplate an annual choice by a Board of Admirals acting under oath to consider only the efficiency of the service, and to be guided by established law and regulations. Both plans may be so administered as to place officers in command and flag ranks at any desired age; both will give increased average ability in the upper grades and both will produce competition. Selection for promotion is necessarily associated with a retirement for age in grades, because it is evidently absurd to retain a man indefinitely in the lower grades after he has passed the age for good work there.

In the selection-for-retirement plan the desired rapidity of advancement through the list is obtained by fixing the number of vacancies that must be made annually in the upper grades so as to bring about promotion at suitable ages.

Therefore, as the two systems will work similarly, if properly carried out with a view only to efficiency, it is obvious that the choice lies with the one which is the more easily capable of good administration.

Selection for promotion seems more comformable to the practice of great business corporations, and it appears the natural and proper method; but against this method it is argued that it will be subject to political abuse, that there will be wire-pulling, and that the officers who obtain promotion will frequently be far from the best. It would create jealousies and heart-burnings to the

injury of the Navy, and finally, with the best intentions, it would be very difficult to weigh and estimate rightly the relative claims to promotion. Those who favor the selection for retirement scheme say that they prefer it because on each point its disadvantages are less than by the other plan. By retirement those who fail are removed from the active list where their dissatisfaction would work harm, yet no one need lose hope and zeal till actually retired. In one case the Board promotes a man because it hopes his future record may justify it; in the other it retires him because it knows his past record has justified it.

Another objection to promotion by selection is that in foreign navies, where it is the rule, the system has a tendency to become one of seniority, so that periodically there occurs a congestion which is relieved by special measures. Such a congestion now exists in the British and French Navies. By the retirement system things would run on smoothly without any tendency to such congestion. It has been urged against all schemes of selection that they are "un-American" and that they are impossible of honest execution because no one can say who is the best or worst man. It must be remembered that the problem is not to find the best man either for promotion or retirement; it is impossible for all to agree on him; the good of the Navy will be subserved if a suitable man is chosen in either case. "There would be vigorous opposition in the Navy especially in its upper half to such a measure, but the broad question is whether the good of the service, or that of naval officers as individuals, shall be the paramount consideration. If the former is to be considered then such a reform is paramount; if the latter is to be placed in front then nothing need be done. A system which promotes all officers to the highest rank before retirement leaves nothing to be desired from the personal point of view."

On reviewing all the seven proposals, it is seen that the only one necessary is either the selection for promotion or the selection for retirement, combined in the former case with an age limitation and sea-service qualifications in each grade. The reduction of the war classes is not absolutely imperative, but is very highly advisable in order to give immediate results from either measure. The other proposals moderate the change to those officers who must suffer for the good of the Navy.

Warrant Officers.—Following the order of the published testi-

mony, we take up the case of the warrant officers, who state that their responsibilities have been much increased recently, while even petty officers now get appointments from the Department, so that the warrant no longer confers its old prestige and authority; and socially, also, they are at a disadvantage with foreign warrant officers. They ask to be commissioned to rank with lieutenants after 20 years' service, and in addition, that any who pass the requisite examination before that time, should be commissioned in the line. While the warrant officers naturally wish to better their position, their testimony does not show that their efficiency will be increased by change. On the contrary, it is clear that no increase of warrant rank as such will ever be advantageous. The reason is obvious: the duties of all commissioned officers frequently call for initiative, discretion and education, as well as for fidelity in their execution; but though very important, the duties of warrant officers are always subordinate, simple, and mandatory, calling mainly for fidelity in their execution. So their present rank is fully adequate to their present duties, whatever may be thought of the advisability of opening a way for enlisted men to obtain commissions in the line or engineer corps through warrant rank.

Enlisted Men.—The testimony of the enlisted men is mainly in regard to the difficulties in the way of drawing their pay as it becomes due, and in regard to liberty while in debt after shipping. The claims of enlisted men to a retired list, and to a chance for a commission after due examination, are also presented. The complaint in regard to pay has now been remedied by Departmental action. The establishment of a retired list has been frequently before Congress, and will no doubt be made sooner or later. The chief obstacle to granting commissions to worthy enlisted men is the fear of breaking up the apprentice system as happened before. If this can be avoided, there is much to recommend the proposal.

The apothecaries and machinists think they should have warrants, as their duties are important, and it is desirable to attract good men.

Staff of the Navy.—The entire Navy is united on the general proposition that changes are imperative, but there are three parties whose personal interests are so divergent, that they will not support each other in any proposed plan of reorganization. These parties are the senior and the junior line officers and the staff corps.

In these circumstances, it will be impossible to satisfy all parties completely, and Congress only can make a wise adjudication among the conflicting claims, because it only can clearly distinguish what is personal from what is general.

The original controversy between line and staff arose out of the efforts of subordinate officers, both of the line and staff, to have their personal status, individual rights and official responsibilities governed by law and regulations, in place of the captain's arbitrary will. In our civil war what had been accomplished in this direction was in a large degree overthrown, as the emergencies of war caused every man to step outside his own duties and his rightful authority in order to help the general situation. So in the interests of a strict chain of responsibility, economy and control, the Department re-established the authority and privileges of both line and staff by a series of general orders and courts-martial, and since then the efforts of staff officers to improve their status has been shifted from a struggle for individual position to an attempt to widen the sphere of their corps, and towards escape from the control of the captain on shipboard, by becoming more directly accountable to the Navy Department. Their position would thus be less irksome on shipboard, but efficiency would suffer.

On the other hand, there has been noticeable a distinct tendency of the Department to limit and restrict the freedom and responsibility of the captain, and make him merely the agent of the Bureaus, as will be seen in the proposals made to the Committee. It should be recognized; personally, staff officers are as well off as line officers, but they complain of their positions, and ask for change, because they do not clearly perceive that they must lend themselves to that unity of command and centralization of responsibility which is an absolute necessity in every sound military organization, and which has been, and still is the rule of the U. S. Navy. Owing to this reason, the statements of staff officers as to the need of their own corps cover only one side of the question.

The Committee of Congress announced that it did not wish line officers to discuss the organization of the staff corps. This was a great mistake. The line of the Navy is the Navy, and the staff corps are auxiliaries. No doubt the work they perform on shipboard is as essential as any other, but nevertheless it is done under the direction of line officers who are primarily responsible to the

Navy Department and the country ; and it is manifestly unwise to allow a body of men whose positions are always subordinate to prescribe their relations to those set over them by the necessities of the service. It must also be remembered that the relations of the staff corps with scientific and professional societies and with the business community are much closer than those of the line, and thus their claims exert on Congress an influence quite independent of their actual bearing upon the efficiency of the service. Let us examine in detail what the staff has asked the Committee to recommend.

Pay Corps.—The Pay Corps asks for nothing except to have its members appointed from the Naval Academy graduates ; but in view of the suggestion to do away with the Corps and have its duties performed by officers temporarily detailed for the purpose, it points out that in such a case efficiency and economy might suffer through the inexperience and lack of interest of officers thus detailed. On the other hand, the advantage of having all officers on board trained to military life is desirable, and perhaps the difficulties of paymasters' duties are exaggerated by themselves. The arguments on both sides are weighty, and the question is one which Congress can decide better than the parties to the controversy.

Constructors.—The Corps of Constructors asks for nothing but an increase of numbers, as it is not large enough to perform its duties thoroughly.

As it seems the settled policy of the country in view of war to maintain a larger number of line officers than are needed to man the ships in time of peace, the difficulty alluded to might be overcome by detailing some of the younger ones for shore duty under the Bureau of Construction. They are sufficiently well versed in necessary technical matters to perform subordinate work creditably, and the influence as seamen which they would necessarily have on the decisions of the Bureau could only be beneficial. In this connection it is interesting to note that the Bureau of Construction has been able to silence all serviceable criticism of its ship designs on the part of seamen by the action of the Secretary in ceasing the detail of captains as general inspectors of ships under construction, on the ground that they asked for too many changes. Ships should suit those that use them.

The Medical Corps—The Surgeon-General asks for the Medical Corps :

1. To have the Chief of Bureau of Medicine and Surgery retain the office until his retirement. The argument offered in support of the proposition is that it would be conformable to the Army method. On the other side, it may be said that perhaps the office would then be looked upon as a reward for past good service and a quasi-retirement, so that its occupants would not work as hard or be as progressive as if they were looking to a re-appointment as a further recognition of good service. The Surgeon-General further asks for a change of titles for surgeons, although the titles would still be indicative of the profession.

The Corps also asks for the substitution of rank for relative rank; but this will be discussed with the Engineer's proposals.

The necessity of a permanent trained Hospital Corps for service afloat and ashore is also strongly urged. The nature of the work to be performed by this corps is so distinct from all else on shipboard that the desirability of retaining properly trained men is perfectly obvious.

Engineer Corps.—In the name of the Engineer Corps the Engineer-in-Chief set forth to the Committee that its needs are included under 5 heads, namely;

1. An increase in numbers.
2. The bestowal of rank instead of relative rank.
3. The examination of chief engineers at each promotion.
4. The legal definition of the duties of the Bureau of Steam Engineering.
5. An Assistant Chief of Bureau.

Increase of Engineer Corps.—In support of the proposals to enlarge the engineer corps, the Engineer-in-Chief stated that there are now 176 engineers in the Navy, of whom 41.5 per cent. are on sea duty, 50 per cent. on shore duty, and 8.5 per cent. on receiving ships or unemployed, and that this number was inadequate to the duties, so that ships now in commission had not their proper quota of officers, in spite of the withdrawal of the officers from colleges throughout the country. It has even been necessary to detail line officers to inspect steel, although that is proper work for engineers. In view of ships building, it is imperative to increase the force of engineer officers. The Engineer-in-Chief then suggests a plan for obtaining 100 additional engineers by transfer of that number from the line of the Navy, selecting them by a board of engineers.

Those opposed to any increase say :

1. A detail of officers as college professors is much desired by colleges, and is a flattering tribute to the abilities of the engineers, but public education is not the business of the Navy, and no increase should be made on this ground.

2. Taking up the dearth of officers at present, it is pointed out that officers on inspection duty at shipyards will soon be available for other work, as no further shipbuilding is authorized. Besides, our Navy is defectively organized in its enlisted force, so that it employs more commissioned engineers than would be necessary with an improved system. The experience of other services shows that a body of competent machinists or artificers to run the engines and perform the mechanical repairs thereto would enable us to dispense with some of the highly educated engineers on every ship, whose appropriate field is in designing machinery and in general supervision on shipboard.

It is denied by many that engineers are overworked on shipboard, except occasionally on some ships on very long voyages, and even that is owing to the unnecessary system of standing a strict watch, the outgrowth of the defective organization of the enlisted force.

As for the new ships it is useless to provide engineers for them unless the enlisted force of the navy is increased also. It may be here remarked that the proposal to transfer 100 line officers to the engineers, when compared with the converse proposal of the "Hale" bill to transfer engineers to the line, shows that to a certain point some officers in both corps are agreed as to the similarity of duties and the capability of the men for both.

Rank and Line Titles for the Staff.—It is said on the part of staff officers that rank is necessary to define clearly their status and duties on shipboard. They do not ask it to confer authority outside the particular department of each officer, and it will not entitle them to command the ship or station where they are. They represent that now they depend on the good will of their subordinates for obedience to their orders; that without it they are subject to indignities, and that the great importance of the Engineer Corps makes it just to recognize it by the bestowal of rank. As for the assumption of line titles with the rank the staff is not unanimous. Those who urge it do so on the ground that it would please them

personally, and that it would increase the consideration in which they are held. Against any change of rank it is alleged that if the desire for rank is for personal reasons it is unnecessary, for every one's status is now assured by law. If it is to carry on duty more effectively it is also unnecessary, for ample authority now belongs to the staff, as is shown by the punishment awarded by a long series of courts-martial for infringement of their authority. If, however, the demand for rank is considered, together with the proposal for making the organization of the engineer's force more distinct from that of the rest of the crew, and for committing the discipline of the corps almost entirely to the hands of its own members, then the bestowal of rank would be bad, for it would threaten the unity of command and responsibility which is now the rule and is absolutely essential in all military bodies.

As to indignities to staff officers, line officers say that they are not attributable to lack of rank, but to the fault of the individual captain; subordinate line officers are equally subject to such indignities, and the remedy is not in a change of law, but in an appeal to it.

As to the assumption of line titles, line officers wish to keep their distinctive titles for themselves, and say that it is wise to have titles indicate the duties of the office. They point out that when the title is a combination of military and professional ones, as in the case of the English Army surgeons, there is always a tendency to drop the professional part in order to appear as soldiers, and so implying that the duties of the staff are not so honorable. A number of years ago, it is said, when such a movement was on foot among navy surgeons, the medical societies of the country defeated it on that ground.

Definition of the Duties of the Bureau of Steam Engineering.—The Engineer-in-Chief wishes to define the field of his Bureau so as to embrace all machinery except torpedoes and gun mounts, and instances the anomaly of the steering engine being nominally under a line officer while cared for by the engineer's force.

Line officers reply that there is no need for change; because what they have done in electricity, with ordnance, and with steel inspection has been well done, and in the case of the steering engine, they say that line officers can look out for it as well as engineer officers, but the working men to care for it are available

in the engineer's force, and economy dictates the arrangement. The point for us to bear in mind is the fact that line and engineers have both done well in a common field.

Next is the proposal to place in the control of engineer officers all boards of survey on engineering machinery, material, etc., and all courts of inquiry and courts-martial on engineer officers. This is to be done on the ground that such matters are the specialties of engineer officers, and that keeping them in the minority on such boards and courts is an undeserved mark of distrust. Line officers reply that were there any distrust of engineers, they would not be represented at all; and they believe that the change would be a severe blow to the efficiency of the service, because it would force upon commanding officers full responsibility for their actions and those of their subordinates, while not committing to them the discipline and control of those subordinates.

At present, the means of enforcing obedience is with those who hold the ultimate responsibility, as it should be.

The Engineer-in-Chief also wishes to make the engineer division subject only to the captain, establishing it as a complete organization independent of all else in the ship. He further proposes to decide by law what shall be a ship's complement of engineer officers. Line officers object to these proposals, because the first is opposed to unity of command and administration, and the second is proper for the Department's decision. Here, as previously, the point to be noted is that the proposal is one which trenches considerably on the present field of the line.

Pay.—Finally, the Engineer-in-Chief wishes to increase the pay of the corps, and base the table exclusively upon length of service This would of course be very satisfactory to individuals, but such a table is found objectionable on general grounds by those who say that pay should depend upon the nature of the services rendered, and therefore should be based upon grades and upon the position held. Applying their doctrine to the present case, they say that payment by grade being proper, if the staff is to be granted rank, its pay should be rather reduced to that of the line, because their position being assimilated, there is no reason for difference in pay.

Marine Corps.—In view of the discussions of recent years regarding the Marine Corps, the testimony before the Joint Committee is

interesting as a full presentation of the marine's side, and as giving their own opinion of their proper sphere of duties. Their case begins by stating that the necessity of marines on shipboard is indubitable, having been recognized from the first establishment of permanent navies; next, the value of the guard duties at navy yards is dwelt upon, and then their superiority over sailors for military duties on landing parties. It is stated that "on board ship they do everything that blue-jackets do except coaling and painting ship." Were the "marines on shipboard, they could also coal and paint. Marine officers could stand watch at sea, as they are Academy graduates." "The duties of marines on shipboard should be enlarged." The commandant of marines wishes them to man the secondary batteries and to have the division always employed as a unit. He believes that there are officers in the Navy who could take a ship manned entirely by marines, except in the engineer department, and such ship would have no equal for efficiency in the service. To enable this to be done, he recommends that the force be increased to 4000 men. It appears, also, that marine officers pass examinations in ordnance, torpedoes and electricity.

The duties of the line and of the marines are more nearly allied to each other than to those of the staff. Line officers acknowledge the important nature of the services rendered by the Marine Corps and bear witness to the high standard of discipline which it maintains as becomes the oldest military body of the United States.

General Conclusion.—In reviewing the testimony before the Committee it seems clear that there are many officers among the line engineers and marines who think that the division of duties among the three corps is an artificial one rather than a natural one, inasmuch as many of them are similar in their nature in the different corps. Apparently these gentlemen would favor a redistribution of duties which would give to the corps of each all those duties which he regards as its natural specialty.

From the same premises, it appears to others that a solution of the question might be found in more or less consolidation of the three principal sea-going corps.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ELECTRIC SEARCH LIGHTS AT SEA.

By J. HEINZ.

(*Translated from Mittheilungen aus dem Gebiete des Seewesens, by Lieutenant H. G. Dresel, U. S. Navy.*)

When the general introduction of the electric search light on board of men-of-war took place not thirty years ago, the metal parabolic mirrors formerly used were even then discarded, and Fresnel or Mangin lenses, the latter invented only shortly before, were substituted. The Mangin invention soon drove out the Fresnel lens, which latter, notwithstanding various defects, was retained for some time in Germany, for the reason that the French firms manufacturing the Mangin apparatus refused to supply it to the German military power, and, also, because the Meniscus ring lenses brought forward as a substitute for the Fresnel lens by the Siemens-Halske firm did not meet the requirements. Later, when the Mangin projector was also supplied to Germany, it stood foremost and alone among search light projectors until a few years ago, when a rival arose in the Schuckert parabolic glass mirror, which, owing to its greater efficiency, may soon supplant the former.

In view of the important rôle that the Schuckert mirror may play, we cannot desist from giving a short description of the characteristic features of this interesting product of optical industry, and of the projector constructed by the Nürnberg Electrical Stock Company, in which the mirror is used.

The Schuckert mirror is made of glass, very thin compared to the diameter of the opening. It is bounded by two nearly parallel parabolic surfaces, the rear one being silvered on the back.

An incident ray from the arc in the focus on entering is bent towards the normal, and on exit away from it. Owing to this the thin parabolic glass mirror gives less chromatic dispersion than the Mangin lens. The parabolic mirror also subtends a greater solid angle, reflecting all rays within an angle of 145°. The divergence of the reflected beam amounts to 3° due to the extension of the arc outside of the focus.

The superior optical advantages of the parabolic glass mirror were established by comparative tests, the results of which were strikingly described by Mr. M. Burstyn, Chief Naval Electric Engineer, in the *Mittheilungen*, issue of 1892 (p. 108).

The other features of the Nürnberg projector in question show some marked improvements over other types. The carbons are adjusted in line horizontally in the axis of the mirror, so that the crater formed on the positive carbon is in the focus and facing the mirror, by which means the light of the arc is utilized to the greatest possible extent. To prevent the flame of the arc from burning upwards, as will result from the rising of the heated air, and which would cause a distorted crater, a small curved plate of iron is fitted underneath and concentric with the positive carbon. This plate is magnetized by the current and attracts the arc down sufficiently to center it in the focus.

The lateral divergence of the reflected rays is produced by the diverging lens, which is double, consisting of two systems of diverging lenses, parallel to each other and which can be approached or separated at will. When separated, the beam is projected nearly cylindrically; when approached within a certain angle, a horizontal divergence of the beam is effected. This is of great utility, as it permits regulating the amount of divergence to suit changing conditions.

We have no precise data pertinent to the resistance of the parabolic glass mirrors against the shocks and strains to which they are exposed on board vessels of war, but it seems that so far they have stood the test well. A point in their favor is that on account of the thinness of the walls it is possible to obtain homogeneous castings free from local tensions.

As the Mangin lenses on board ships still outnumber the parabolic glass mirrors about ten to one, the remarks in the following pages, unless it is stated to the contrary, will apply to the Mangin reflector.

Projectors and lamps of the following dimensions and powers are in use on board ships:

Diameter of mirror.	Current.		Approximate candle power.	Work necessary in electric H. P.
Centimeters.	Volts.	Ampères.		
90	45–55	80–120	40,000	4.9–9.0
60	45–55	50–65	35,000	3.0–4.9
40	45–55	30–50	20,000	1.9–3.7
30	45–55	11–20	3,000	0.7–1.5

The German Navy makes an exception to this rule, as some vessels carry search lights with Schuckert mirrors of 100 centimeters diameter, requiring a current of 150 ampères. In determining the size and number of search lights for a vessel of war the displacement is generally taken into consideration, so that battleships are provided with 90 centimeter lights, where torpedo and patrol-boats are provided with the smallest sizes.

This arrangement does not appear entirely practical to us, for the reason that in time of war much greater demands will be made upon the search lights of cruisers doing scouting duties than upon those of the line-of-battle ships. It is also desirable that the lighting systems on board torpedo and patrol-boats be enlarged, which cannot be done, however, until the present turbine machines are improved or replaced by some other more efficient motor.

There are, as a rule, three different heights, depending upon need, at which search lights are placed on board ships. They are placed either in the military tops, or at the height of the upper deck (on the bridge, on the fore-castle, on the poop, above the gun turrets, etc.), or in ports on the gun-deck. The high installations offer the advantage that persons upon the bridge or superstructures are less exposed to the blinding effects of the beams of light, and also that they enable the light to be projected over intervening obstacles upon distant objects. With the installation upon the upper deck the direct communication of orders to the men operating the search light is facilitated, and powerful projectors can, without appreciable cost, be advantageously disposed in such localities as will secure to them a wide zone of action. The disposition of the projectors in battery ports or special ports nearer the water-line per-

mits the operator to light up an approaching torpedo-boat without having to constantly change the elevation.

Although it is impossible on board ship, in every case, to post the observer in a position most advantageous for observing the illumined object, yet a decided advantage is gained when this observer, who controls the operation of the projector, is not compelled to be in its immediate vicinity.. To enable this to be done, in many ships speaking tubes were fitted leading from the post of the observer to the projectors. They, however, have proved unsatisfactory in practice. Of late years the difficulty is being met by systems of controlling the projectors electrically from a distance.

The apparatus constructed by the Electric Company (formerly Schuckert & Co.) of Nürnberg, for the electric control of the search light projector consists of two electric motors fitted to the pedestal, one controlling the train, the other the elevation. The armatures can revolve to the right or to the left and communicate their motion to the projector frame by means of gearing. Rheostats are interposed in the armature circuit as well as in the field-magnet circuit, by means of which the speed of the armature is regulated. The arrangement is such that for increasing the speed more resistance is thrown into the circuit of the field, while the resistance of the armature circuit is lessened ; for slowing down the reverse takes place. A switch board for operating the mechanism and for distributing the current to the motors contains the rheostats. It is probable that this apparatus will soon come into general use.

Rules governing the number of search lights allowed to vessels differ in different navies. In some navies four, three, or even only two search lights are thought sufficient for battleships ; the large Italian ships carry not less than six, most of which, however, are only 40 centimeters in diameter. Of these six one is placed in the top, the other five in deck ports, two on each broadside, one astern. The first has an all-around sweep of 360°, and each of the others controls an arc of 170°.

On vessels carrying a small number of search lights the installation in battery ports is very seldom used.

Only a few general rules can be fixed upon for governing the use of the search light in time of war. It cannot be questioned that on account of hostile torpedo-boats alone the search light will come into play when formerly a fleet extinguished or carefully masked its lights in order to guard against discovery by the enemy.

A moving fleet in time of war will have its search lights ready for instant use from sunset to dawn, and will even operate some of them constantly to light up the track on all sides within certain ranges so as to prevent surprise by the enemy's torpedo-boats.

Before a ship or a fleet decides upon operating its search lights weighty reflection must be given the fact that, although under most favorable circumstances the lights will detect objects at distances up to 3500 meters, they will betray the presence of ship or fleet to the enemy at distances far beyond this range. When once decided to use the search lights, their operation must be conducted systematically and in strict conformance with the rules, predetermined by the commanding officer, that best apply to existing conditions.

Such rules, aside from their dependence upon the manœuvring or battle formation assumed by the fleet, must be based upon principles established by actual experience and tests of search lights at sea, particularly when operated in fleet manœuvres.

One of the most important of the fundamental rules is that, in order to secure the greatest advantage in detecting objects, the observer's line of sight must make an angle of from 25° to 60° with the axis of the projected beam. But the dimensions of ships do not permit a sufficiently large interval between observer and light to bring the angle within the above limits, especially when objects at a distance are observed. In such cases better results can be secured from the search light of a neighboring ship, properly posted, than from the lights on the observer's own ship.

This case is illustrated in Fig. 1, where *A* represents the vessel operating the search light; *C* represents the object lighted up, and *B* represents a second vessel occupying a position advantageous for observing the object *C*.

FIG. 1.

The visibility of distant objects is hindered by allowing the beam to sweep to and fro. If the beam remains stationary and originates in a projector placed low down, the pupils of the

observer, stationed on the upper deck, accommodate themselves to the lights and shadows, especially when divergence of the rays is resorted to. Under these circumstances the detection of objects in the lighted field is surer than with rapid sweeping. This rule it is well to observe in defense against torpedo-boat attacks.

A beam interposed between a distant object and the observer so as to cross the latter's line of sight will partly mask the object which, although lighted up by a second beam, will appear less distinct than when the intersecting beam is removed. Thus, if a beam from *A* (Fig. 2) were projected between *C* and *D*, an observer

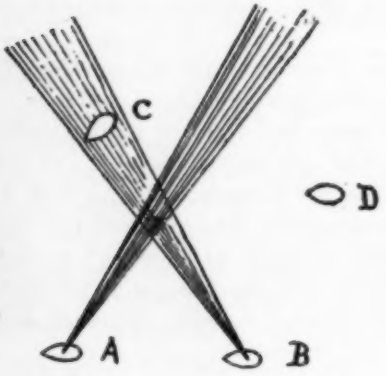

FIG. 2.

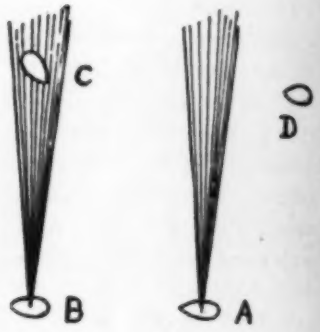

FIG. 3.

at *D* would see an object at *C* less plainly, even though *C* be lighted up by a beam from *B*. Similar conditions obtain in the case illustrated by Fig. 3.

These experiences indicate that, under certain circumstances it would be a disadvantage in fleet movements, to operate simultaneously two search lights on the same side of a vessel; for, one of the beams will obscure the view from the decks of a neighboring vessel of an object lighted up by the other beam, or at least, forcibly interfere with it. Fig. 4 illustrates this case, where the second beam from *A* obscures *B*'s view of *C* which is lighted up by the first beam from *A*.

An exception to this rule, not to operate simultaneously the

lights on the same side of a ship, is the case in which the two beams are joined as nearly as possible into one, working together so as to prevent any discontinuity in the illuminated field. This combination in a special case is shown in Fig. 7.

Experiment shows that the visibility of an object under the rays of a search light varies directly with its reflective powers. The greater the contrast in color or shade to the surrounding water the more distinctly will the object appear.

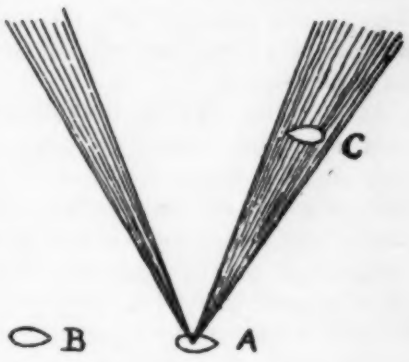

FIG. 4.

To reduce this reflection and consequent visibility to a minimum, different kinds of "dead" or lustreless paints have been tried on torpedo-boats, and although it was found impossible to get a color which would suit all the varying conditions of the water surface, yet it is an acknowledged fact that the greatest advantages are secured to a torpedo-boat by coating it with a dark "dead" paint. This color may, at a distance, practically render the boat invisible at night, yet the unavoidable bow-wave, which shows up distinctly under the rays of the search light, will reveal the presence of an approaching torpedo-boat long before the latter itself is recognized. Furthermore, a color suited for night work does not, as a rule, serve the same object in day time.

In practice, two principal methods of operating the search light are advocated. One method is to project a steady beam in a fixed direction, forming a sort of boundary or sentry line which no vessel can traverse without discovery. The other method is to keep a sector of the horizon under observation by sweeping the projected beam to and fro in regular periods of oscillation. In both methods the amount of lateral divergence given to the rays will depend upon circumstances which may require changes in amount from time to time. This is accomplished better by the Schuckert double diverging lenses than by any other appliances.

We will now consider a few special cases of the effective use of search lights in time of war for scouting or other duties, and will begin with a proposition on the employment of this new defensive weapon in a fleet at sea, with the object of keeping off night attacks of torpedo-boats.

It is assumed that the fleet consisting of 12 battleships, 9 large and 4 smaller cruisers, 3 signal repeating vessels or tenders, 8 torpedo-boat catchers, and 12 torpedo-boats, is on a cruise in waters where no immediate meeting with a hostile fleet is probable, but where torpedo-boat attacks are to be constantly expected. Under such circumstances it is not advisable to keep the fleet in battle formation which, in compliance with modern fleet tactics, would occupy a too extended order for our purpose and be unsuited to the effective repulse of a torpedo-boat attack. On the contrary, the main body, consisting of the battle ships, should take a compact or massed formation so that it may be encircled by a girdle or chain of cruisers whose search lights will sweep the field around the fleet to their extreme effective ranges.

The manner in which we think that this problem may be solved is shown in Fig. 5.

The battleships are formed in three columns abreast, the flagship at the head of the center column, occupying a rectangle whose sides are respectively 3200 and 1600 meters long. Each battleship has a torpedo-boat in tow. Those torpedo-boat catchers not assigned to special positions, will take positions abreast and outside of the wakes of the first, second and third battleships in the two side columns. The tenders have no fixed places and are, therefore, not shown in the sketch. Around this main body twelve cruisers form a circle of 3600 meters radius. The cruisers operate their search lights, as shown in the figure. If scouts are required ahead, cruisers 10, 11 and 12 may be sent out for that purpose, in which case the rear battleships of the three columns will operate their after search lights to complete the light circle.

The distance between the main body and the cruisers, as shown in the sketch, has to be ample, viz., 2000 meters, in order to leave a sufficiently broad zone, exposed to the rapid-fire guns of the cruisers and battleships, which a torpedo-boat that has managed to pass the cruisers will have to cross before getting within launching distance of the battleships. This distance has to be

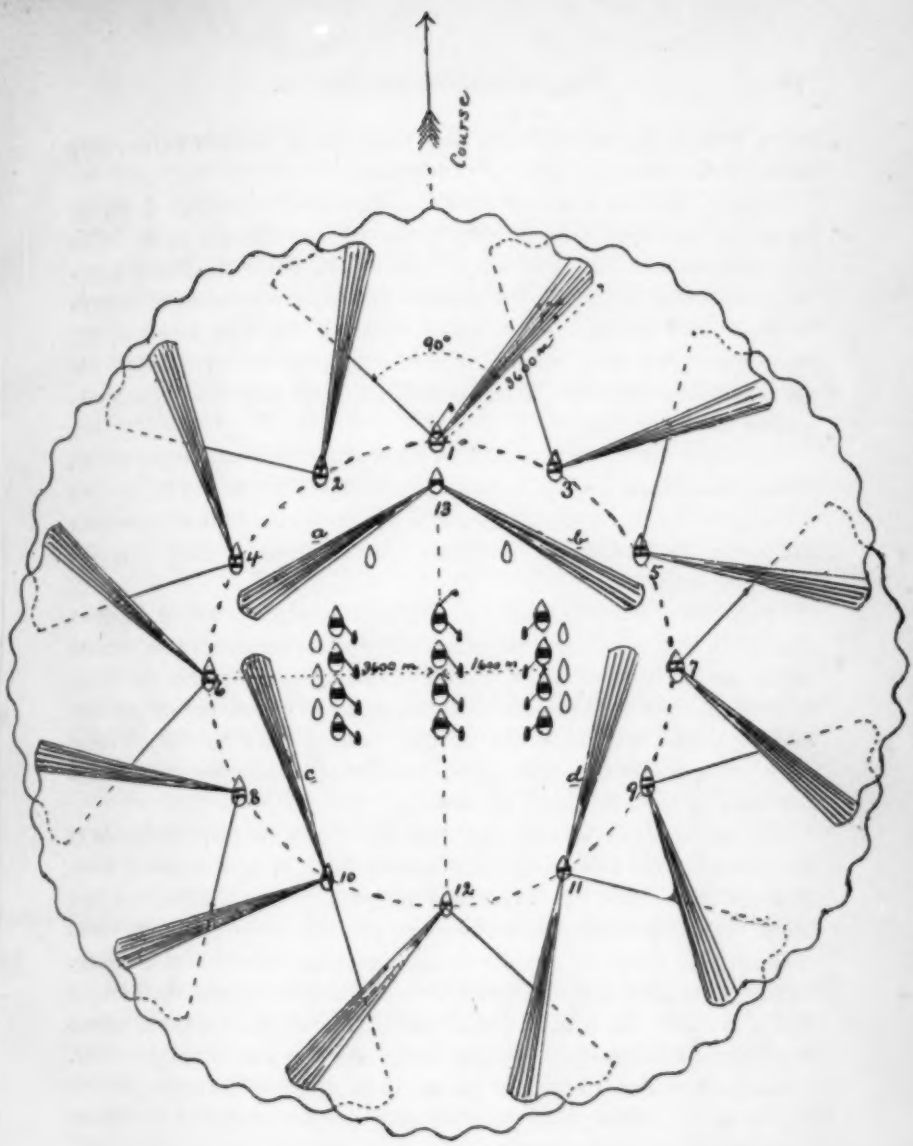
Course
90°
3600 m.
1800 m.
a
b
c
d
1
2
3
4
5
6
7
8
9
10
11
12
13
Battleships
Large Cruisers
Small Cruisers
Torpedo-boat-catchers
Torpedo-boats

FIG. 5.

large, also, in order to lessen the chances of vessels of the fleet hitting each other by stray or wild shots.

Each cruiser has a sector of 90° assigned to it, which is to be swept by the search light in periods of one minute each. The sweeping of the field will be synchronous, the time being regulated with that of cruiser No. 1, thus avoiding intersections of rays from several vessels. The divergence of the rays is set at 7°, from which it will be seen that with a turning speed of 1½° per second, every point in the sector will be lighted up for 4½ seconds during each minute.

A greater divergence would be desirable in many respects, but it was found inadvisable, as an increase above 7° would bring with it too great a decrease in range; and it is to be noted that even with the above limit satisfactory results can be obtained only from the very best apparatus.

The relative positions of the cruisers in Fig. 5 fit the case of Fig. 1, so that an obect, for example, which happens to be lighted up by the beam from No. 1, will be plainly seen by one or the other of the neighboring cruisers. As soon as a vessel or suspicious-looking object is sighted, the cruiser making the discovery will at once bring a second search light into play, the latter to be kept continually bearing upon the object.

Further security against stealthy approach of torpedo-boats is furnished by the low-lying fixed beams of light *a*, *b*, *c* and *d* from cruisers 10, 11 and 13. The search lights of the battleships and other vessels are not operated except in case of necessity or when cruisers 10, 11 and 12 are not in the positions shown in the sketch. In the latter case the rear three battleships will operate their search lights towards the rear in a manner similar to the cruisers, unless the commander-in-chief should order them to use diverged light, when each one of the three vessels will bring projectors, not exceeding three in number, into play, so as to keep a sector of 60° under constant illumination.

We will now turn to several questions of a tactical nature which should not be separated from the present topic.

The formation proposed above in connection with employment of the search light can be assumed in the darkness of the night only when some *starting point* is secured for regulating positions and distances; that is, there must be a base line, the formation of

which is controlled by direct measurements, and there must also be at hand means of establishing positions by angles or bearings. In the formation under consideration the leading column would be the basis of the fleet, where the distances between the vessels are regulated by angling on two lights of limited range and separated by a known vertical distance. The intervals between columns may be regulated by cross bearings of the colored position lights of the head and rear vessels of the leading columns. Cruisers 6 and 7 verify their positions by angling on the side lights of the head and rear vessels of the neighboring flank columns. Cruiser 1 takes position by angling, over the low fixed beams from 13, on the lights of cruisers 6 and 7, etc.

The carrying of colored side-lights by the battleships for the purpose of regulating positions is not especially objectionable as the visibility of these lights is far surpassed by that of the girdle of light produced by the cruisers. The commander-in-chief may order them to be extinguished at the beginning of an action.

The comprehension of signals should not meet with unusual difficulty in this formation. For signals of attention or of warning signal-horns might be used in the columns, steam whistles or sirens in the main body, and rockets for the fleet in general. It is inadvisable to employ torpedo-boats or torpedo-boat catchers for carrying despatches at night; they are liable to be mistaken for hostile attacking boats and draw upon themselves the fire of their own cruisers or battleships. In many cases it will be necessary to use flash signal lamps of restricted arc so as to be visible only in the intended direction.

In addition, there must be a simple system of signals free from any chance of misinterpretation, perceivable at once by every vessel in the fleet, and referring to evolutions for defense against torpedo-boat attacks.

As regards these evolutions, it is emphatic that they be carried out promptly on account of the high speed of torpedo-boats, also that the conditions holding at the time of attack be considered. For example, it is not of the same moment whether the fleet at the time of attack have its torpedo-nets down or up, or whether the attack comes from ahead, from the flanks or from the rear.

Many authorities protest against the use of torpedo-nets by vessels underway except when breaking through a blockade. We

believe, however, that a fleet of the above nature may be placed in situations where the torpedo-nets would prove very desirable, although their use will necessitate a reduction of speed to 5 knots in order to prevent lifting of the nets. It is understood, of course, that only the battleships of the main body will employ their torpedo nets, if at all. The movements of cruisers cannot be hampered by any such adjuncts.

Cruisers, at all times, will manœuvre so as to keep beyond effective launching range of torpedo-boats and will endeavor, in the fleet formation under consideration, by rapid-fire from their secondary batteries to disable the torpedo-boat or to force it to such a strait as will render futile its operation directed against the battleships.

In this connection, commanding officers of vessels must bear in mind that it is no easy undertaking at night for a torpedo-boat to successfully launch a torpedo against a rapidly moving cruiser at considerable distance away; also, on the other hand, that if a torpedo be launched from astern along the wake of a vessel it will tend to remain in the wake, even with slight turnings in the same, thus following up a vessel, rather than leave the agitated water caused by the propellers. It is presupposed that unless accidents occur cruisers will generally be able to successfully ward off torpedo attacks. It is different, however, with the slower battleships in fleet formation, which prevents free manœuvring.

The condition most favorable for repulsing a torpedo attack is when there is time and opportunity to change heading away from the point of attack, by a simultaneous turning to port or starboard, as the case may be, of each vessel of the fleet. Again, referring to the case of Fig. 5, suppose that the attack is made from the port hand. If the cruisers are alert and discover the attacking boats in time, then when the first shots are fired the enemy's boats will still be 5000 meters distant from the main body, which would require, with courses converging at right angles, about nine minutes' time before the boats approached within effective launching range. If the cruisers' alarm signals are perceived and understood promptly on board the flagship there still remains time enough for the commander-in-chief to execute with the main body a change of course to starboard of eight points. The signal to be used might be started by sounding the siren from the flagship, to

be taken up by the vessels of the columns; in addition, a number of rockets may be sent up simultaneously, followed by Very's lights, which latter also indicate the intended change of course. If this change of course be effected within five minutes from the first alarm, the torpedo-boats, which have approached to 2000 meters during this time, will require seven minutes more to reach effective launching range if the fleet is steaming away at 10 knots speed.* In the meantime each one of the four vessels of the left column, which by the change of course have become the rear vessels of the formation, will bring its three after search lights into play with 20° divergence in each, so that fields of 60° are lighted up. The rear vessels increase their speeds to close up on the vessels of the leading column forming in echelons, so as to enable the vessels of the leading column to direct the fire of their secondary batteries through the intervals of the rear column. The commander-in-chief joins the rear column, bringing his after search lights into play; the torpedo-boat catchers take up suitable positions on the flanks and open fire with their batteries, together with the torpedo-boats which have steam up, but do not leave the sides of their consorts. The commander-in-chief may order shrapnel fire at discretion.

Taking into consideration that some of the cruisers will also join in the engagement, one arrives at the conviction that a one-sided attack not of the nature of a sudden surprise, directed against the flanks or rear of the fleet, will stand but little chance of success.

As a result, torpedo attacks upon a fleet at sea will probably be made from several sides with divided forces, one a feint perhaps, which would make the adoption of the above manœuvre questionable in the extreme.

The difficulties that the fleet encounters will be greatest when a vigorous attack is made from ahead, because, independent of the confusion that would ensue should a flank attack occur at the same time, there is not time enough for the battleships to turn 16 points for the purpose of making a running fight, which is least favorable to torpedo-boats. The operation of the search lights in this case will have to be confined to the cruisers, while the battle-

*This supposes that the boats are fitted out with 18-inch Whitehead torpedoes, which possess an effective range of 800 yards and a speed of 27 knots.

ships extinguish all lights and resort to their torpedo-nets, trusting to the darkness and protection afforded by the nets for their safety.

To prevent an attack from ahead the advanced scouts will be reinforced, and search lights will be operated, some with fixed some with sweeping beams, so as to produce a flood of light towards the front, which any enemy will pass around rather than attempt to transverse. If certain that an attack will come from a known direction the circle of cruisers may be elongated towards this direction so as to take an elliptical shape.

The employment of one's own torpedo-boats or torpedo-boat catchers for counter attacks upon the enemy requires great precautions against possible mistakes. When emerging suddenly out of the darkness they are liable to be taken for hostile boats and treated accordingly.

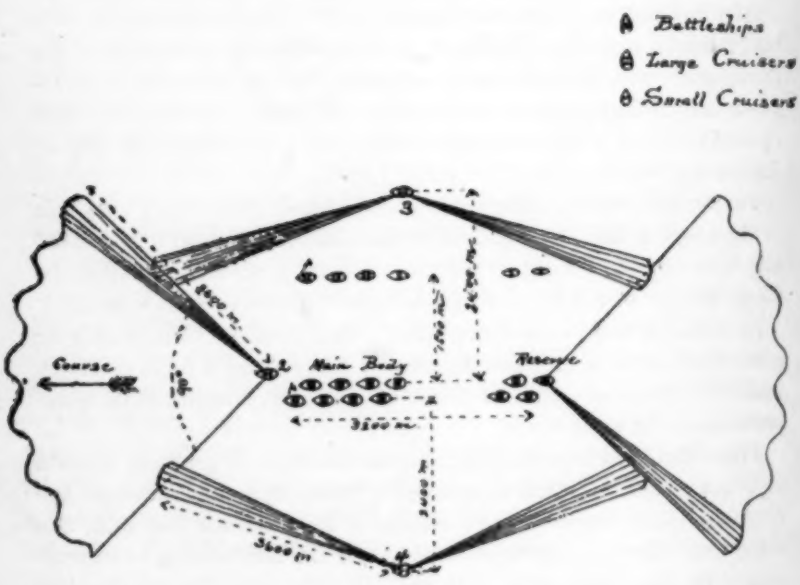

FIG. 6.

It may be remarked here that the proposed circle of cruisers, with its diameter of 7200 meters, offers area sufficient for placing

the armored ships and reserves in extended battle formation, as shown in Fig. 6, without disturbance of the girdle of cruisers.

This evolution from cruising to extended battle formation, without breaking the circle of outposts, may take place preparatory to changed conditions, such as the possibility of meeting a hostile fleet.

If there are strong indications that a probable engagement is near at hand, the majority of the cruisers are assembled, while three are retained outside of the formation, as shown in Fig. 6, cruiser 2 sweeps the field ahead of the fleet with her search lights; cruisers 3 and 4 cover the flanks with fixed beams of light, while the rear is covered by the lights of the rear-most battleship of the reserves. The torpedo-boat catchers and tenders, not shown in Fig. 6, take separate positions at some distance from the fleet proper.

Whoever agrees with our preceding views on the operation of search lights at sea will no doubt also admit that the proper handling of this military apparatus requires not only thorough technical knowledge, but also natural aptitude, a seaman's experience and several years of drill and practice. The latter is imperative. The drills should be frequent and practiced under various conditions and situations.

As a protection to vessels of war at anchor the search light plays an equally important part.

Modern war operations do not preclude the case where vessels of war may have to come to anchor for purposes of making repairs, obtaining stores, or other missions, in anchorages which do not give the same security as a military port or harbor chosen for a rendezvous of a fleet.

The protection secured to vessels in such anchorages depends not only on the organization and composition of the mobilized coast defenses, but also upon the configuration of the coast and islands, as well as upon the navigable features of the waters.

A glance at the charts will show along the coasts of Dalmatia, Schleswig-Holstein, Finland, etc., any number of anchorages where a vessel, by placing submarine mines in the channels, could be well protected against surprise by hostile men-of-war.

We do not deny that the enemy can break through such improvised lines of submarine mines by sending hulks against the

defenses to explode one or more contact mines, by dredging with light-draught boats, or by cutting cables leading to observation stations. All of these operations, however, require time and facilities and expose the attacking force to great losses.

The precautions to be taken against torpedo attacks are less simple. Torpedo-boats may be looked upon as the "*passe-partouts*" of modern types of war vessels, so that certain channels, entrances to harbors, etc., can be made impassable to them only by extraordinary defenses and by the exercise of unrelaxed watchfulness.

How fatal the neglect of such measures may prove, is exemplified by the case of the Chilean iron-clad Blanco Encalada sunk while at anchor in Caldera Bay, on the night of April 22 to 23, 1892, by torpedoes from the Almirante Linch, and Almirante Condell.

In order that the defenses of vessels at anchor in the harbor be effectual, the barriers to the passage of torpedo-boats should be placed well in the foreground, as far as possible removed from the larger vessels. A great part of the appliances for the erection of these defensive barriers cannot be carried on board the battleships. They must be furnished by the coast defense department, through supply-ships or vessels intended for such purposes. These appliances include: the material for mines; coast defense torpedo-boats; patrol-boats; cables, hawsers and timber for booms; torpedo-nets; rapid-fire guns on field carriages; electric search lights mounted on wheels, as well as dynamos, batteries and motors for their operation, etc.

Together with these artificial defenses, an anchorage can be most effectually protected if nature has lent a helping hand. Thus, along the above-mentioned coasts there are many anchorages which can be made inaccessible to larger vessels by planting a comparatively small number of mines, and can be guarded against torpedo-boats by means of the material enumerated. Even though vessels intend to remain at anchor for a short time only with the certainty that the enemy will not learn of their presence in time to organize a fleet movement towards their capture, yet this does not preclude the possible discovery by the enemy's torpedo-boats. It is imperative that precautions be taken against surprise by the latter, and in all cases should be proceeded with quietly, and that care be taken not to attract the enemy's attention.

If coast defense torpedo-boats and patrol-boats are at hand they will use their search lights, while making their rounds, only in cases of absolute necessity; they will exercise extreme care in the making of signals. Flash lights, shielded so as to be visible within a narrow sector, are recommended for this purpose. The vessels at anchor will avoid making signals visible at any great distance; they will have search lights ready for immediate use, not to be operated except in case of urgency; they will resort to torpedo-nets for defense, and if circumstances permit, will further strengthen their position by the erection of obstructions in the approaches.

When impossible to longer conceal the position from the enemy the most thorough measures for defense will be taken. The manner of placing mines and other protections in harbors, channels, etc., have been frequently discussed, so that we content ourselves by merely mentioning a few facts connected therewith, having in mind, not a fortified roadstead for fleet rendezvous, but an anchorage, sheltered to some extent by islands, etc. Naturally the search light will play a prominent part, its method of operation depending upon attending circumstances.

With the possession of search lights, motors and other requisite machinery mounted on wheels for field use, it may be possible from the configuration of the harbor to move the apparatus far ahead of the anchored fleet, so as to command the entrances, thus securing a field of light similar to that obtained ordinarily from a vessel sent to the front for that special purpose. With such apparatus it is recommended to project fixed streams of light across the harbor entrance close to the surface of the water, so that no vessel can pass undetected. As soon as any entering vessel is discovered it will be the duty of a specially detailed vessel to bring its lights to bear upon it continuously, so that effective gunfire can be maintained.

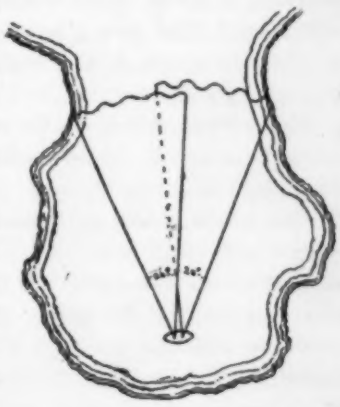

FIG. 7.

A constant illumination of a harbor or roadstead can be accom-

plished from a ship by two slightly lapping fans of light, each with a divergence of 20°, as shown in Fig. 7.

The great speed of torpedo-boats demands their detection at comparatively long distances in order to allow sufficient time for disabling or destroying them by means of the rapid-fire guns. It is also to be remembered that the 18-inch Whitehead torpedoes carried by the latest type of torpedo-boats possess an effective range of 800 yards, as well as surprising accuracy. Torpedo-nets only protect the vital parts of a ship against torpedoes launched from a thwartship direction.

The vidette boats cruising outside the anchorage will communicate with the fleet by signals, but will not attempt to enter the harbor at night, as they will be taken for the enemy and fired upon. A beam directly crossing the field ahead of a fleet will act as a sort of curtain, masking the fleet from view of the enemy beyond.

The search light is an indispensable adjunct of torpedo-boat catchers, torpedo-boats and patrol-boats. The torpedo-boat catchers will find it especially useful, not only in the search for hostile torpedo-boats and during operations against hostile vessels, but also for purposes of navigation, for signaling, and in connection with patrol duties. In attacks against vessels, torpedo-boats will not, as a rule, operate their lights; an exception is made when a few boats that do not join in the attack operate their lights from a distance to mask the contemplated attack or to mislead the enemy by a feint.

The employment of the electric search light during night engagements between vessels has not yet occurred, but it is safe to predict that it will occur.

As a result it will prevent the confounding of friend and foe, which history shows to have taken place in the past. It will not only disclose the enemy's manœuvres, and subject him to more effective fire, but the glare of the projected light will materially interfere with the accurate aiming of the enemy's gunners. The installations in military tops are especially favorable, as owing to their location persons on deck or at the guns will not be dazzled or blinded by the rays. It is not to be expected that projectors will remain unharmed for any length of time in action, as they offer too good a target for small calibered rapid-fire guns.

Although opportunities have been wanting to test the utility of the search light during action, yet its advantages in connection with military operations have repeatedly been exemplified. Thus, in the winter of 1881 to 1882 the Imperial Austrian squadron by means of its search lights and machine guns subdued the rebellious Dalmatians in the Bay of Cattaro. The English fleet under Admiral Seymour, in 1882, by means of its search lights prevented the Egyptians from erecting water batteries at Alexandria on the night of July 11th. The occupation of Sfax by the French and the landing of English troops at Ismaïlia were accomplished under the rays of the search lights. The Italians have used it repeatedly in their colony on the Red Sea. In conclusion, we may mention the operations of the French Admiral Courbet in the Min river, and the Spanish engagements at Melilla, in which the search light was used.

For night signaling it is well adapted. The beam of light, resembling the tail of a comet, is projected into the air, and by flashing it upon a convenient cloud, or even in a clear atmosphere, the Morse alphabetical code can be transmitted to great distances. These distances do not compare with those of the heliograph dependent on the sunlight, and sending signals to a distance of 120 sea-miles. The range of the search light for such purposes under favorable circumstances, scarcely exceeds 25 sea-miles. There are other points, however, in the latter's favor, especially fitting it for work at sea. In the first place, it does not require a steady platform; secondly, the flashes are visible all around, and not confined to a line joining the two stations, as with the heliograph; finally, it can be used when the two stations are concealed from each other as by an intervening promontory, island, or hill. For purposes of flashing signals, the Schuckert projector is fitted with a signaling apparatus consisting of shutters which are opened or closed by a hand grip. This apparatus is secured by bolts to the front face of the projector, and may be detached when not in use.

We beg to mention a plan proposed by Lieutenant Boyer of the French Navy, published in the *Revue Maritime et Coloniale*, for applying the search light in a special way to avoid collisions at sea. He proposes the introduction of an electric search light above a

steamer's ordinary mast-head light, with rays of limited divergence, which will indicate a vessel's course at considerable distances. Owing to the increasing speed of steamers, the chances of collisions have increased in recent years, and some method of the above nature serving to lessen the dangers will be gladly welcomed.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ELECTRIC FIRING ON BOARD SHIP: ELECTRIC PRIMERS AND FIRING ATTACHMENTS.

By Lieutenant Stokeley Morgan, U. S. Navy.

Electric primers have been issued to our service for a number of years, but their use has been limited, owing to the unreliability of the usual electric circuits on board ship and the want of a simple and ready method of making the necessary connections. Percussion primers still remain the principal means of firing guns on our vessels, with friction primers as an alternate, and electric primers are carried only as auxiliary or for experimental purposes.

The advantages of electricity are so great, however, that it is intended in the near future that it shall be used exclusively for firing heavy guns and torpedoes, although for use in B. L. rifles of the ordinary type, it may be advisable to carry friction primers as an alternate. In firing by friction or by percussion, quite an appreciable interval of time must elapse between the impulse to fire and the ignition of the charge. This delayed action has been a fruitful cause of inaccuracy in target practice, and with a movable gun platform it becomes a matter of great importance. It is due partly to the flexible laniard usually employed and the travel of the parts of the firing mechanism, partly to a personal equation of the gun captain. By the use of the electric current the first of these causes is very much diminished, the second exists with any method of firing. When the gun is to be discharged from some distance, as in turret guns, or when a torpedo is to be discharged from the conning tower, the superiority of an instantaneous method is most apparent.

With electric primers the danger from premature fire is very much lessened, as it is impossible to fire before the breech is entirely closed and locked. Also, fixed ammunition with percussion primers is liable to explode in handling; with electric primers this danger is removed.

One disadvantage, which some will consider a serious one, must be mentioned. It is the difficulty in locating the fault should a miss-fire occur; whether it lies in the primer, the battery, the leading wires or some of the contacts is not apparent at a glance. The remedy lies in having the primers as nearly perfect as possible (and they can be made fully as reliable as others), and by frequent tests to keep the firing circuit always in order. If it is in order when the gun is cast loose, there is as little likelihood of its failure during the firing as of any other portion of the mechanism. It may be advisable to put a tell-tale or sounder on the firing key circuit, and to provide an auxiliary circuit to be used in case of failure of the principal one.

The greatest difficulty heretofore to the introduction of electric firing has been to secure a reliable source of energy. It has not been considered advisable to use the dynamo circuit, in which case, all guns would be dependent upon a common source, the disablement of any portion of which would disable them all, but rather that each mount should carry its own battery and thus be entirely independent.

Fortunately, a primary battery has been found that answers every purpose. After exhaustive experiments at the Torpedo Station, the Exeter Dry Battery was selected as the one best adapted to the work, and it has been adopted by the Bureau of Ordnance. The elements are carbon and zinc with the exciting liquid held in an absorptive substance. There is no leakage nor are gases given off by the chemical action. The cells are put up very compactly in tin cases and sealed. They have been given very thorough tests for endurance under intermittent service, such as would be required on board ship; for efficiency under abnormal conditions, as when sealed and submerged, and when exposed to excessive heat and cold. Under all circumstances they have proved satisfactory.

The standard firing battery consists of three of these cells connected in series, giving an electro-motive force of 4.4 volts, a

current of 5.5 ampères short circuited, and having a battery resistance of 0.8 ohms. The battery is put up in a wooden box and then enclosed in a sheet iron case made perfectly water-tight. This is bolted to the gun mount in some convenient place out of the way of the mechanism. One pole of the battery is put in metallic connection with the mount, the other is brought by a conducting wire to the firing attachment. The primer case being in contact with the gun, the return circuit is through the gun and mount. As the whole external portion of the firing circuit has a resistance of about one ohm and the primers as now designed are ignited with about 0.6 ampères of current, it is seen that the energy of the battery is ample.

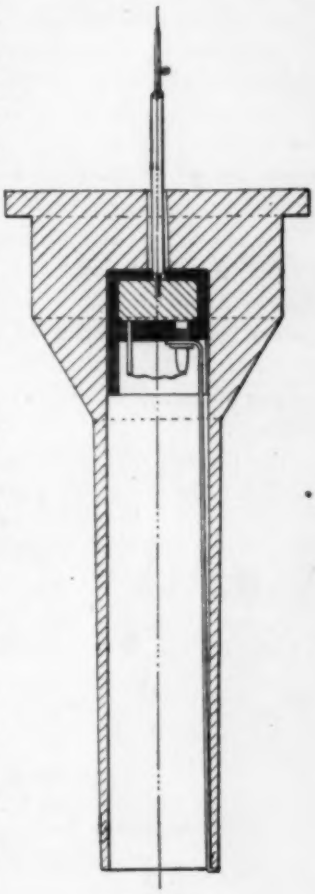

FIG. 1.

A new design of electric primer has lately been adopted by the Bureau of Ordnance for use with B. L. rifles (ordinary type) and is now being issued to the service. It differs from the old standard primer in that it has a single leading wire, the stock itself being the other terminal. The stock is of brass, the external form being the same as that of the percussion and friction primers now in service, so that it can be used with the same spring lock by removing the percussion wedge and putting in place the one for friction or electric firing. When in place in the vent the leading wire projects through a slot in the wedge and is fitted with a cone-shaped brass terminal for connection to the firing circuit. If the issue of percussion primers is discontinued, the present spring lock, which has given a great deal of trouble, can be done away with and a much simpler device used.

The interior arrangement of this primer is shown in in Fig. 1.

The leading wire (of No. 26 B. & S. insulated wire) passes through the base of the stock and is soldered to an insulated copper disc. The bridge is made between two studs, one being in contact with the disc, the other with the stock by a long, thin copper tang, soldered at the mouth. It is a very fine wire of platinum-iridium alloy (90 per cent. plat., 10 per cent. irid.), $\frac{3}{16}$″ in length and .002″ in diameter, or of an equivalent cross sectional area. The electrical resistance of the bridge is about 0.6 ohms, and it is designed to fire with a current of about 0.6 of an ampère. It is primed with a wisp of dry gun cotton, and the rest of the case is then filled with fine meal powder and closed at the mouth with a paper disc and shellacked.

For use with fixed ammunition an electric primer was designed by the Bureau of Ordnance, and after being perfected by the Winchester Arms Company, adopted for use in the service. All late orders for 4″, 5″ and 6″ rapid-fire cases are to be fitted with these primers. It has the same external form as the present percussion primer stock and is held in the base of the cartridge case in the same manner.

The interior arrangement of the primer is shown in Fig. 2. Connection to the firing circuit is made through the firing-pin which, when the breech is closed, is held tightly against the insulated head of the central contact post. The bridge is made betwen two copper rings, one being in contact with the central post, the other with the primer stock. The outer ring is held firmly in contact with the bridge by a cap-shaped spring, which also serves as a gas check. The dimensions and electrical properties of the bridge are the same as in the primer for B. L. rifles.

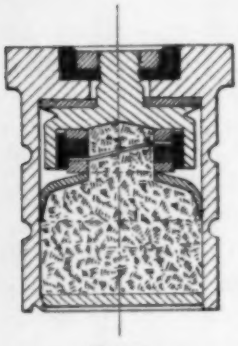

FIG 2.

These primers are now made with such care and the shop inspections are so exacting as to insure their being almost perfect.

FIRING ATTACHMENTS.

For use with electric primers in R. F. guns with fixed ammunition an electric firing attachment has been adopted to take the place of the ordinary percussion firing mechanism. It consists of

a steel case screwing into the breech-plug and carrying through its center an insulated steel pin. Into this case screws a transverse arm also carrying an insulated pin. Steel springs hold the axial pin firmly against the primer head in the base of the cartridge case, and the transverse pin against one terminal of a lug bolted to the breech of the gun.

This lug takes the place of the lug which holds the percussion trigger box in place. Its other terminal, a binding post, is connected to one pole of the battery by an insulated leading wire. It is also fitted with a screw socket to receive the double pole terminal of the firing-key.

As the breech plug is turned into the locked position, the transverse arm revolves and the pin comes in contact with the terminal on the lug; the circuit can then be completed through the firing-key. The gun cannot be fired until the breech is locked, for the circuit can only be completed at that point.

The firing-key consists of a split, wooden handle, hinged at one end, the contact points being held apart by a spiral spring. It is wired with a duplex flexible copper conductor. A brass case encloses the end of the key, so arranged as to take the strain off the connections of the leading wires. A ring is also provided, which, being threaded on the finger of the gun captain, allows him free use of his hand.

The firing-key terminal screws into a water-tight socket on the lug, and remains permanently in place while the gun is cast loose.

As a premature fire might occur as soon as the breech was locked if there should be a short circuit in the firing-key circuit, it has been thought necessary to place a safety socket in the wire leading from the battery to the lug. This consists of an ebonite case with spring socket slipping over a cone-shaped terminal. The wire is secured to the oscillating slide and to the lug by clamps, and is of such length that the circuit will be broken by the recoil of the gun. It is intended that the circuit shall be completed at the safety socket only when the gun is ready to fire.

For use with B. L. rifles (ordinary type), a similar attachment lug is bolted to a convenient place on the mount. One terminal is connected to a pole of the battery, the other by a leading wire is carried to a clamp on the breech face of the gun, and thence to

the primer terminal. It has a spring socket in an ebonite case to receive the primer terminal, and the connection is readily made.

It is very necessary that this connection should not be made until the breech is closed and locked to avoid premature fire, but to insure against such accidents even after the breech is locked, it was thought necessary to place a safety socket in the battery wire, similar to the one used with rapid-fire guns.

The firing-key and terminal are the same for all guns, and all sockets, keys, clamps and terminals are interchangeable.

As the firing-key circuit is only in place while the gun is cast loose, a screw cap is furnished to protect the interior of the socket at other times. All wire used for firing circuits should be of the best quality. The insulation should be of rubber or okonite, and all wires should be tinned. Cotton braid should not be allowed between the wire and the insulation. The sizes of conductors, whether solid core or stranded, should not be less than No. 18 B. S. gauge. For the firing-key circuit the insulation should be braided over all, on other circuits it should be taped.

Electric firing attachments have been fitted to all the 5″ R. F. guns now in service, and they are being made for the 4″. The heavier guns of the Monterey, Minneapolis, Columbia, Cincinnati and Raleigh have also been so fitted.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

A MESSENGER PIGEON SERVICE IN CONNECTION WITH COAST DEFENSE.

By Lieutenant Austin M. Knight, U. S. Navy.

The Institute has from time to time, during the past few years, published reports of the progress made at the Naval Academy, under the direction of Professor Marion, toward the development of a messenger pigeon service for use in connection with the defense of our coast, together with brief notices of the far greater progress made abroad in the same direction.

The following data and discussion are submitted for the purpose of bringing the record up to date, and in the hope of arousing a somewhat greater interest than exists at present in regard to this important work.

Experiments in communication from the practice ships to the Academy were continued during the season of 1894, with results which fully confirm the conclusions of Commander Chester's report of the preceding years (see Proceedings of U. S. Naval Institute, No. 68).

Briefly summarized, the results of last summer's experiments were as follows:

The total number of flights was 100; the distance varied from 20 to 200 miles. The results of the most important flights are tabulated below.

	BIRDS RELEASED.		
Distance from Annapolis.	Distance off Shore.	Time.	Arrival at Annapolis of first bird.
200 miles.	62 miles.	June 17, 9.30 A. M.	June 17, 5 P. M.
200 "	40 "	" 18, 9.30 "	" 18, 5.45 "
*200 "	56 "	July 6, 11 "	July 7, 8.30 "

* These birds (4 in number) had been kept on board the Monongahela for 21 days, between decks, without sunlight, confined most of the time in close box, and the remainder of the time in a dark store-room.

All of the birds included in the above table had had some training in flying over water, and all had flown before over a part of the route here involved.

During the whole summer, nine birds failed to find their way home. Of these, three were among the oldest and most reliable birds belonging to the Academy. They had been trained over Chesapeake Bay and were perfectly familiar with it. By chance, they were released (from the Bancroft) directly off the entrance to Delaware Bay. Without a moment's hesitation, they started up this bay, apparently mistaking it for the Chesapeake.

The following is the endorsement of the Superintendent of the Naval Academy upon the report of the work done by the Academy loft up to the spring of 1894 :

UNITED STATES NAVAL ACADEMY,
ANNAPOLIS, MARYLAND, *March* 13, 1894.

Respectfully forwarded.

1. Experiments made with the homing pigeons at the Naval Academy have, in my opinion, demonstrated that their use can be made valuable in receiving communications from vessels operating near the coast, and that the pigeon service should be established on some recognized basis.

2. Professor Marion's voluntary aid in developing the usefulness of pigeons has been valuable because of his zeal in the cause, and his familiarity with the subject, and I think it merits commendation.

R. L. PHYTHIAN, *Captain, U. S. Navy,*
Superintendent.

No one who thoughtfully considers the results thus far attained can fail to realize that a carefully organized and systematically trained pigeon service would be of great value to the Navy in time of war; but it seems worth while to consider somewhat in detail a few special points in connection with the subject, with a view to defining as clearly as may be, not only the possibilities but the limitations of such a service.

It will be observed that the greatest distance directly off shore involved in any of the above experiments is 62 miles, and there seem to be no records of birds having been released at distances greater than this from the *nearest shore*. It is, therefore, altogether uncertain from how great a distance they might be relied upon to find their way to the coast. This is probably only a question of the keenness of their vision, which is known to be marvelous, and of

the height to which they can rise. It is not necessary that they should recognize the shore, but only that they should see it, for it is found that they make directly toward it until they recognize some landmark, when they shape their course for home. The birds released from the Monongahela off the Carolina coast, invariably headed for the nearest land.

There seems to be no reason to doubt that they can be trusted to reach the coast from the greatest distance at which they can see it. It is important that experiments should be made to determine what this limiting distance is. In the absence of such experiments, it seems not unreasonable, considering the height to which the birds can rise and the remarkable keenness of their sight, to assume that the distance will not be less than 150 miles. Professor Marion is of the opinion that it is from 200 to 250 miles.

It is necessary here to admit a limitation with regard to thick weather. Such weather is very unfavorable on land, but would of course be much more so at sea, where the first requisite of success is, as we have seen, ability to make out the coast from a considerable distance. On land, among familiar marks, a bird might make its course without seeing very far at any time; but at sea, clear weather would be absolutely essential. On the other hand, fogs are commonly low-lying, and it might happen in many cases of fog that the birds will rise at once into an atmosphere perfectly clear. Experiments here would be valuable.

Another limitation is found in the fact that the birds do not fly at night. For this reason it would probably be useless to release them at such an hour and such a distance that they could not reach the coast by nightfall. If they had time to reach the coast but not to reach a cote, their messages would not be delivered until morning. Under the general system which is proposed by Professor Marion, however, cotes would be distributed in such a way that a bird reaching the coast at nightfall would probably recognize and seek refuge in one of these rather than elsewhere. Thus its message might even be delivered earlier than if it had time to reach its own home. This system contemplates the establishment of cotes in conspicuous positions near all lighthouses and lightships, all to be built and painted exactly alike. This would almost absolutely insure the delivery at some station of every message; for not only birds in need of rest for the night, but those

reaching the coast at unfamiliar points would be attracted to places so closely resembling their homes. It is assumed that telegraphic communication exists with all lighthouses, so that messages could be forwarded instantly upon receipt. In the case of lightships, and of outlying lighthouses, a relay pigeon service would be established with the nearest point of telegraphic connection.

As illustrating the value of such a service as is proposed, let us consider the case of a fleet entrusted with the defense of that part of our coast from Block Island to the capes of the Delaware. Whatever position might be taken up by such a fleet, there would be thrown out many miles beyond it a line of light, swift vessels as scouts, and upon the rapidity with which these vessels could communicate with the inner line and with the shore would depend, in large measure, the success of the defense. Suppose a vessel of this outer line to discover an enemy's fleet standing to the westward; she would hasten toward the squadron of defense or toward the nearest point of the coast from which it might be possible to communicate with that squadron, with Washington and with the cities threatened, and if not overtaken by an enemy's cruiser or by a shell from a battleship, and if she did not break down, she would ultimately communicate the fact that at a certain time—already long past—an enemy's fleet, of unknown strength, was standing in for some unknown point on the coast. Let us suppose, now, that instead of hastening off herself she could despatch a number of pigeons with the certainty that they would carry the news quite as surely as she could carry it, and far more quickly; and that then holding the enemy in view, she should follow his movements, and from time to time send off new messengers with particulars of his strength, his course and his apparent intentions. It is not difficult to see the immense value of a system which promises the possibility of such service as this.

Assuming, as demonstrated, that rapid and certain communication can be established from ship to shore, it is important to inquire whether it is also possible to communicate from the shore to a ship lying off the coast.

At the first thought, it seems altogether improbable that such a thing should be found practicable. Yet there is reason to believe that the idea is very far from being visionary. Undoubtedly, the limitations would be much narrower than in the reverse case; and

it may be that they would prove too narrow to leave any practical value to the system. But this is to be demonstrated. It is certain that the birds can be taught to regard a ship as their home, and to seek it and regain it from shore, the ship being a considerable distance at sea; and this in spite of rather wide changes of position. If we consider, however, the case of a ship a hundred miles or so off shore, we must inquire whether the bird could see so small an object at so great a distance, and whether seeing she could recognize it. It is not inconceivable that, by gradual systematic training with distances slowly increasing, this might be accomplished; but the difficulties are great, one of them being the probability of confusion arising from the general resemblance of one ship to another. Experiments are needed here. But they would require much time, and could not be made without considerable expense.

An important question is how long the birds can be confined and still be trusted to find their way home promptly. One set of birds released from the Monongahela had been kept for 21 days. They should have reached Annapolis on the day of their release, but did not arrive until the following morning. It should be said, however, that their strength had undoubtedly been impaired by the closeness of their confinement, the Monongahela having no suitable arrangements for keeping them.

It has been proved by repeated experiments abroad that the birds, if kept under conditions such as will not impair their strength, may be trusted to find their way home promptly after weeks of confinement.

The speed of the best birds released from the Monongahela during the summer was about 30 miles per hour for the 200 miles covered. This speed, although excellent considering the opportunities that exist for training the birds, is far below what has often been attained, and what may be expected if a regular system should be adopted and money made available for the purchase, breeding and training of the very best birds.

In Belgium, where pigeon breeding and flying have found their highest development, a distance of 215 miles has been covered at a speed of over 70 miles an hour. This, however, is to be regarded as altogether exceptional. An average speed of 40 miles for short distances is recognized as very good.

With all the limitations which have been pointed out above, the

value to the Navy and the country of such a service as that proposed is out of all proportion to the expense involved. This expense is estimated by Professor Marion at $5000 for the first year, and at considerably less for subsequent years.

Objections have been made to this trifling outlay on the ground that in case of necessity the hundreds of homing pigeons owned in the United States could be drawn upon. It will be clear, from what has been said, that this view of the case is utterly false, in that it ignores not only the months needed to domesticate the birds in new homes, but the fact that long and careful training is needed to teach the birds to fly over water. Such a system as is needed will require not days or weeks, but years for its development, and the work cannot be begun too soon.

It is much to be regretted that no appropriation for beginning this work is included in the Naval bill for the coming year.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE NAVAL WAR COLLEGE.

It need hardly be said that the practical problem proposed for solution by the Naval War College and solved during its last session has presented another strong argument for the necessity of maintaining that institution. That the study of such subjects is very important indeed, no one having the real efficiency of the service at heart can well doubt. The solution of a definite practical problem is a tangible and interesting reality, all the more satisfying if a trifle difficult and intricate. As with the result of the survey of a portion of coast, or of a bay, as shown on paper, so it is with the result of the problem; from the map different pilots may lay out different routes or courses, all of which may be equally good; in certain contingencies only one can be used. The map and routes will represent a great amount of work done, and the necessity for making the survey will be best demonstrated by the result of the survey itself. So it is with the problem. All the solutions are no doubt good, and it may safely be asserted that the officers who attempted them are now convinced of the value of such work, of the necessity of doing it, and, from the time required, of doing it in advance. It may well be said that a preliminary war-survey of the waters around New York has now been made.

No better estimate of the good work accomplished by the College, and of its aims and purposes, can be formed than are furnished in the closing address of its worthy President. We present a few extracts.

ADDRESS DELIVERED TO THE CLASS AT THE NAVAL WAR COLLEGE, UPON THE CLOSING OF THE SESSION OF 1894, BY CAPTAIN H. C. TAYLOR, U. S. N., PRESIDENT OF THE WAR COLLEGE.

[*Extract.*]

The true theory of a successful system, whether it be of education or of other affairs, is to permit in the beginning and before we have experience to guide us, the natural evolution of the work, without binding it too much in any set direction by hard and fast regulations and limitations. Thus, as the evolution progresses, the system will yield to the pressure of natural forces, and will be swerved from time to time by these forces and by the necessities of the situation, into paths varying somewhat from those which were originally in the minds of the projectors.

This process, though it may appear to have about it something of the "*laissez aller*" principle, is nevertheless based upon sound reason, provided always that it is accompanied by intelligent and untiring interest and watchfulness on the part of the persons connected with it. However much this idea should weigh in all undertakings, it is more needed in systems of education than in other affairs, and above all is it desirable in a system where those desiring information are men of mature experience, and officers of high standing, whose instruction must come principally from their own desire to learn, and not from extraneous causes or impulses.

The lectures of the course naturally grouped themselves as follows:

Under the head of "Weapons of Offense and Defense," we have the gun, by Lieutenant Meigs and Professor Alger; the ram by Commander Harrington and Naval Constructor Capps; the torpedo, by Lieutenant Holman; and armor, by Lieut. Commander Couden.

Another group of subjects comprised: Naval engines, by Engineer McFarland; the construction of ships, by Naval Constructor Capps; electricity in warfare, by Commander Maynard; and signaling by Commander Bainbridge-Hoff and Lieutenant Niblack.

Outside of these groups there were the general discussions of strategy and naval policy, by Commander Stockton; the principles of naval tactics, by Captain Taylor; the land operations of the navy, by Captain Wallach; the data provided by Lieutenant

Wilson and Ensign Marble ; and lastly the work of Major Calef on land strategy and Professor Snow on international law.

The result of these lectures has been to quicken our professional interest and to excite our desire to perfect ourselves in the art of war.

The idea of this summer's course outside of the lectures has been primarily based upon the desire to promote professionally a mental activity, and to dispel a certain passive condition of the brain which receives and passes in review all questions that are brought before it, but which does not of its own accord seek for such questions.

This mental condition of receptivity, if I may call it so, is to be expected in a profession of arms which, at the end of a long peace of thirty years, has become much affected in its reasoning processes by an established routine, long continued and unbroken. Thus, in exciting with war problems a condition of mental activity concerning professional matters, the lectures themselves will fall upon fresh mental ground, and will in this way produce their best results.

It was due to this belief that the introduction of war problems was decided upon ; they were chosen also for the reason that they would give some valuable material results, even should they not produce the mental effect which was anticipated. In fact, it was hoped that the solution of such problems, and the preparation of plans of defense would, if continued, prepare for our navy in future war, plans of campaigns in the realms of both strategy and tactics, which would be of great value in the confusion of sudden war—as was Von Moltke's portfolio to the German army in its French and Austrian campaigns. There seemed also no more thorough and fitting method of learning the art of war, than in doing these very things ; for it may not be doubted when men of such high intelligence as our naval officers possess are confronted by these questions, that the search for the principles that should govern their solution will inevitably lead them into close intimacy with the art of war.

I confess to you gentlemen that our anticipation in this respect has been more than realized; and that the introduction of these problems into the course should have produced such interest in officers' minds, is a source of much satisfaction to all those interested in the continuance of this College, and in a reasonable prepa-

ration of the naval mind for the true and natural practice of the profession of arms.

I hope you will not measure the work done by what appears on paper. Very good work has been submitted, and most creditable to the intelligence of those who have formulated it. But this is only a portion of the earnest reasoning and reflection which has been produced by the consideration of these problems. If this feature of the course has had the effect we believe it has in turning the minds of officers towards the art of war, it will have done the work that was desired.

I have spoken hitherto of the principal problem of the summer. There have been sub-topics of this problem which have interested many officers. The defense of the Race, Gardner's Bay, Peconic Bay, and of other localities whose strategic importance make their tactical qualities prominent, have attracted the attention and concentrated the able efforts of several officers. Among these the plans of Lieutenants Rush and Peacock and Ensign Anderson for mining and for other means of defense have strongly influenced our views of the tactical situation. We have listened to various ideas as to the tactical defense of these and other ports; they cannot fail to be of value, for it has been the experience of all, that the plans of others, even when not agreeing with our own, serve a most valuable purpose by suggesting fresh ideas and new methods.

This is not the time and place to dwell upon the different plans of strategy to which this problem has given rise. They will be later compared and described, and I will be glad to send you an account of them. They are:

First.—Giving Captain Mahan his proper place of precedence—the plans advocated by him and Commander Stockton, and others of the staff and class—of withdrawing our fleet into New York before the enemy's advance and from there inflicting upon him such injury as is possible.

Second.—The plan of Lieutenant Calkins—of choosing a position such as the Nantucket waters as a port of sortie, from which we may operate upon the enemy, and draw him away in whole or in part from his true objective of New York.

Third.—The principle upon which was based the paper of Lieut.-Commander Bleecker, Lieutenant Rush and Lieutenant Peacock,

viz.: To hold the line that has Sandy Hook upon its right wing, and the Race and adjacent waters upon its left wing, and when forced back from that line, substituting the line of Sandy Hook and New Rochelle.

Fourth.—The plan advocated by Commander Dyer, which provides for the division of the fleet in two parts—one, the heavy ships of slow speed, to hold New York, while the lighter and swifter portion of the fleet is to choose a port of sortie and operate upon the enemy's communication.

Fifth.—The plan of Commander Leary, which provides for a decided battle being forced by us upon the Sandy Hook detachment, between November 10th, when we shall be ready, and November 15th, when the larger fleet of the enemy appears off Montauk; and returning after this battle to our base at the Race, there to contest it with the enemy's second fleet, or to retire into New York, with the choice of Sandy Hook, for a time at least, as an unobstructed outlet.

Sixth.—The plan of Commander H. W. Lyon, which coincides in general principles with that of Lieutenant Calkins, but which develops with exceptional clearness and insight the various tactical features upon which depends the success of the strategic idea which underlies this able plan.

Still another proposed by one of our rear-admirals is that we should accept battle at the Race, assisting ourselves by mines and all other tactical advantages, and sacrifice our fleet at that point, if necessary, in order to seriously cripple the enemy.

From other officers outside the College we have also had many suggestions, and I hope to have many more.

Another of the principal features introduced in this course has been the War Game. It is not new, and has been played before at the College, but has not been taken up as a serious element of the work.

In summing up the War Games, I think all of you will agree with me that much of strategic geography and strategy may be learned from the game as we have played it.

The War Charts and Defense Plans constitute another feature, dependent somewhat upon the exigencies of strategy and tactics we have to consider in our War Problem. This work should not cease, but should go forward slowly with the permanent staff dur-

ing eight months of the year, and more rapidly when the class comes together during regular sessions. No one thing in coast defense is more important than a close examination of localities with a view to utilizing them most effectively.

War charts by Lieut. Commander Bleecker, Lieutenant Rush, Lieutenant Peacock, Ensign Anderson and Lieutenant Wilson have been submitted.

The accuracy and value of war charts and defense plans and the instruction in the art of war gained by the officers in preparing them is much affected, in my opinion, by becoming personally acquainted, through frequent visits in all weathers, with the scene of tactical operations. I press this upon your attention. It is a defect of the day; one of the defects of a long peace—to rest satisfied with a chart at a desk, instead of an examination of the plan on the ground itself. The chart is a substitute—a necessary one, of course—but should not be our main reliance.

The lateness of the season in which our Steam Launch Work was begun has prevented our making much progress with it, but enough has been done to indicate the possibilities of tactical instruction contained in these exercises. We hope to continue it, guided by the experience which Commander Perry has gained in the work, and which he has lately communicated to us. It is not expected that these exercises can in any way take the place of large ships' evolutions; but it is believed that long continued work with the launches may point the way to the kind of drills that are desirable for those ships to undertake. Many formations practicable for these boats will not be so for the large vessels, but on the other hand those manœuvres which are found impracticable for the launches will surely be so for our squadrons of men-of-war; and in this way many visionary formations will be eliminated from the list of possibilities.

The idea of placing before the officers certain problems or situations in international law was conceived with the same purpose as that which governed the introduction of war problems in the art of war course, namely, to create and foster a more active interest in the principles of the science by applying them to hypothetical but probable cases in naval experience.

It must be finally for the navy to decide whether it wants a School of War or not. If a large majority of officers wish it, and express

that wish strongly, I do not doubt that it will be continued. And on the other hand, if the navy does not want it, let us not spend our strength in useless striving to give the navy what the navy does not want. Only, first of all, let the navy know what this thing is that they are to approve or reject. Let them understand what this School of Naval Warfare is; what its methods; what its aims; and this they will best learn from the officers now present.

From my point of view I should sum up the summer's work briefly as follows:

First, we have begun to gather certain plans for the defense of our coasts, which gathering will continue, if the College endures, and extend to other portions of the coast, until in time the entire shore line of the United States will be covered by a strategic and tactical preparation resembling the condition of German military defense when after thirty years of similar work, the great wars with Austria and France tested the Prussian system to its core.

Our plans will be formulated and ready for instant use. They will be based upon the reliable data collected and furnished by the Office of Naval Intelligence, whose cordial co-operation has been of such valuable assistance to us this summer. In addition, while preparing these plans, in the study of the principles of warfare necessary to perfect them, of naval and military history in order to utilize past experience, and in the lectures of experts, keeping us abreast of the latest developments of tactical forces and weapons, we shall learn the immutable laws that govern the Conduct of War.

Secondly, we have by means of the College work begun to excite an active interest in the minds of officers concerning this, the highest and most important department of their profession.

Gradually, as this work goes on, some naval minds will turn to it in preference to those other studies and researches which have so long engrossed them. The present close attention to mechanical details, of construction, of ordnance, of engines, of electricity, of explosives, will be replaced in some officers' minds by these other questions of strategy and tactics. A number must continue, of course, to concern themselves with the mechanisms; admirable work has been done in this direction, and such work will always be needed, and my hope and expectation is only that some few of our bright minds will devote their abilities to considering how we shall combine these ships that we are building into effective squad-

rons for tactical usefulness, and to studying the laws of strategy, in order to know where and how to dispose of our squadrons in order that the country may secure their natural and proper effectiveness.

These two results, gentlemen, appear to me to contain the essence of our summer's work, and as such I submit them for your consideration.

My hope is that these results will in time become so apparent that we may be encouraged by naval approval to continue this work with vigor, and that this School of War, founded by the perseverance and intelligence of Admiral Luce, and later fostered and elevated by the genius of Captain Mahan, may continue a career of usefulness to the Navy and the country.

PROFESSIONAL NOTES.

THE LESSONS OF THE ENGAGEMENT OFF THE YALU.

[*A letter in the London Times.*]

Sir:—There is—it may be freely admitted—no small presumption in asking you to find room for a letter on the engagement off the Yalu after the very able manner in which it has been dealt with by the writer of the article on "The War in the East" in *The Times* of this morning. An event like the recent engagement, however, is so rare, and the consideration of it is of such great importance to a naval people like ourselves, that you may be willing to admit to your columns another and rather more minute discussion of its details. Such a discussion has been made possible by the valuable telegram in *The Times* of yesterday from your special correspondent at Chefoo, to whom every student of naval warfare in this country ought to be grateful.

The composition of the contending fleets—as reported in the telegrams from both sides published during the last few days—is given in the following tables, which are taken from Lord Brassey's "Naval Annual" for the present year, except as regards the two Chinese gunboats. These are assumed to be of the Epsilon and Zeta type, and their tonnage and armament are taken from Brassey's "British Navy," vol. 1, 1882. In the statement of the guns, light pieces, such as the 12-pr. of the gunboats and field and boat guns in other ships of both fleets, are omitted, for they were probably not used.

Lord Brassey's lists do not contain the number in the crew of a ship, so that I am not able to give them; but there is reason to think that the Japanese were—though, perhaps, not largely—superior in number of officers and men to the Chinese. The Ping-Yuen, Kwang Ting, and the two gunboats might, perhaps, be excluded from the list of Chinese vessels, as, owing to their having been "detached to guard the entrance of the harbor," they took little part, and apparently no effective part, in the action. The gunboats are of a class not designed for employment in fleet actions; and it is difficult to imagine for them any other occupation in that off the Yalu than hampering the movements of their more mobile consorts, if they ranged themselves in formation with them. The only recorded instance of the gunboats' participation in the fight is that of firing the last shot in the action "when the enemy were out of range." The two Chinese gunboats and the Japanese "steam packet Saikio Maru, which had been fitted up with guns as a cruiser," will therefore be omitted from the comparison of the respective forces which I am about to make.

The Chinese fleet carried 98 guns, including quick-firers of the smaller natures. The Japanese fleet carried 178. The number of machine guns carried by the Chinese was 81; by the Japanese, 54. As far as number of shot goes, the Japanese could direct against their enemy a fire greatly superior to his. This superiority was even greater than would appear merely from the foregoing figures; because, whilst the Chinese had only 56 Q. F. guns of all natures, the Japanese had no less than 123. Even these latter figures do not express with sufficient precision the real superiority in amount of fire which the Japanese could bring to bear on their opponents. The Chinese had only

14 Q. F. guns of 4.7 in. caliber, the 12-cm. piece being considered as of that caliber, to which it approximates closely enough for the purposes of the present comparison. The Japanese had, as against the 14 of the Chinese, no less than 59 Q. F. guns of 4.7 in. or higher caliber. In view of the character of the action—which, as stated in your article of this morning, "was fought at comparatively long range," when the smaller quick-firers could rarely be used with effect—the superiority of the Japanese fire, at all events in the number of shot discharged and the consequent reasonably greater probability of hitting, appears to be overwhelming.

The Chinese Fleet.

Ships' names.	Displacement.	Armor (in inches).		Guns.	Torpedo discharges.	Speed, knots.
		On belt.	On turret, barbette, or battery.			
	Tons.					
Ting-Yuen.....	7,430	14	12	Four 30.5-cm., two 15-cm., eight machine	2	14.5
Chen-Yuen.....	7,430	14	12	Four 30.5-cm., two 15-cm., eight machine.	2	14.5
Lai-Yuen.....	2,850	9½	8	Two 8¼-in., two 6-in., seven machine....	4	16.5
King-Yuen.....	2,850	9½	8	Two 8¼-in., two 6-in., seven machine....	4	16.5
Ping-Yuen.....	2,850	8	5	One 10.2-in. Krupp, two 6-in., eight Q.F.	4	(?)16.5
Chih Yuen.....	2,300	..	10	Three 8-in., two 6-in., seven Q. F., two 47-mm. Q. F., eight 27-mm. Q. F., six machine.	4	18.0
Ching Yuen....	2,300	..	10	Three 8-in., two 6-in., seven Q. F., two 47-mm. Q. F., eight 27-mm. Q. F., six machine.....	4	18.0
Tsi-Yuen.....	2,355	..	..	Two 21-cm., one 15-cm., nine machine.	4	15.0
Chao Yung.....	1,350	..	..	Two 10-in., four 4.7-in. Q. F., seven machine.....	3	16.8
Yang Wei.....	1,350	..	..	Two 10-in., four 4.7-in. Q. F., seven machine.....	3	16.0
Kwang Kai.....	1,030	Hull partly of wood.		Three 12-cm. Q. F., eight machine.	4	16.5
Kwang Ting....	1,030	Hull partly of wood.		Three 12-cm. Q. F., eight machine.	4	16.5
Gunboat.....	440	..	..	One 11-in.....	..	10.0
Gunboat.....	440	..	..	One 11-in.....	..	10.0
Six torpedo-boats	..	..	..	.....	..	....

The Japanese Fleet.

Ships names.	Displacement.	Armor (in inches).		Guns.	Torpedo discharges.	Speed, knots.
		On belt.	On turret, barbette, or battery.			
	Tons.					
Matsusima.....	4,277	..	12	One 32-cm., 11 12-cm., five 6-pr. Q. F., 11 3-pr. Q. F., six machine.....	4	17.5
Itsukusima.....	4,277	..	12	One 32-cm., 11 12-cm., five 6-pr. Q. F., 11 3-pr. Q. F., six machine.....	4	17.5
Hasidate.....	4,277	..	12	One 32-cm., 11 12-cm. Q. F., six 3-pr. Q.F. six machine.....	4	17.5
Chiyoda.....	2,450	4½	..	Ten 12-cm., Q. F., 14 4.7 Q. F., three machine.....	3	19.0
Fuso	3,718	7	9	Four 24-cm., two 17-cm., five machine.	..	13.2
Hiyei.....	2,200	4½	Hull composite.	Three 17-cm., six 15-cm.....	..	13.0
Takachiho.	3,650	..	..	Two 26-cm., six 15-cm., two (?) Q. F., 10 machine.....	4	18.7
Yoshino.....	4,150	..	..	Four 6-in. Q. F., eight 4.7-in. Q. F., 22 3-pr. Q. F.....	5	23.0
Naniwa.....	3,650	..	..	Two 26-cm., six 15-cm., two (?) Q. F., 10 machine.....	4	18.7
Akitsushima ...	3,150	..	..	One 32-cm., 12 12-cm. Q. F., six machine.	4	19.0
Akagi.....	615	..	..	One 24-cm., one 12-cm., two machine.....	..	12.0
Saikio Maru...	..	..	..	"Fitted with guns as a cruiser."	..	....
Four torpedo-boats.....	..	..	..	.....	..	....

The Chinese had the superiority in one particular of their gun armament, which is occasionally affirmed to be all-important, viz., in heavy guns. Of the 98 Chinese guns no less than 27 were "armor-piercing" of and above 8-in. caliber.

Of the 178 Japanese guns, only nine were of a higher caliber than 7 in. The Chinese had the superiority in another particular of their armament, which also is sometimes affirmed to be all-important. They had 42 torpedo-discharging arrangements against 32 Japanese.

In one element which we have become accustomed—during the last 25 years, that is—to hear extolled, viz., greater size of individual ships—the Chinese were superior. The united tonnage of the Ting-Yuen and the Chen-Yuen—14,860—exceeded by more than 2000 tons the united tonnage—12,831—of the three largest Japanese ships—the Matsusima, Itsukusima and Hasidate.

The Japanese had the advantage of their opponents in speed, but to a less extent—all things considered—than might be expected. The number of knots shown against each ship in the lists is, of course only a "best possible," and is equally delusive for both sides; but it can be used for purposes of comparison. Omitting the gunboats for the reasons already given, it is seen

that the lowest speed with which any Chinese ship is credited is 14.5 knots; whereas three Japanese are of less than 13.5. In a general action the relative slowness of even a few individuals must lower the general rate of speed of the fleet; and it may be taken for granted that the speed of the Japanese never came anywhere near that attributed to the Yoshino, or even that attributed to the Takachiho and the Naniwa. Notwithstanding all this, the Japanese had so much the greater speed that they were able to "play round" their opponents to some extent. It ought to be added that it is probable that the Japanese ships, or many of them, had been longer out of dock than the Chinese. What this would imply will be readily understood by any one who is acquainted with Chinese and Japanese waters, and has observed the great rapidity with which ships' bottoms get foul, and the diminution of speed caused thereby.

From this survey of the characteristics of the two fleets, it may be perceived that each fairly represented a different principle. The principle represented by the Chinese was that advocated by the school which puts material above personnel, for their fleet contained the biggest ships, the less numerous but heaviest guns, and the most extensive torpedo armament. The principle of which the Japanese may be taken as the representatives is that of the school which appeals to history and experience, and not to theories evolved out of the inner consciousness of people without practical knowledge of the sea, and which maintains that the human factor is both the most important and the unchanging factor in war, which must in its broader features remain much what it has always been.

The lucid comments on your Chefoo correspondent's telegram contained in *The Times* of this morning, render it unnecessary to describe the various movements during the battle with the same minuteness as that with which the composition of the contending forces has been discussed. The engagement took the following form:—Admiral Ting, with 10 ships in some formation not exactly known, but not single line ahead, started at a seven-knot speed to meet the approaching Japanese fleet, which, sooner or later, getting into single line ahead, passed round the starboard, or right flank, and astern of the Chinese fleet, and, coming upon its other flank, steered in the same direction as that in which it was proceeding, and continued to exchange with it an animated gun-fire, scarcely ever at close, and generally at very long, range. The Chinese fleet in the course of the fight got broken up into two parts. One consisted of the two large barbette ships, which were engaged by seven of the principal Japanese ships. The latter moved round an outer circle, usually at long distance from a smaller and inner circle, around which the Chinese barbette ships moved. At the same time a kind of independent action was going on between the five inferior Japanese ships and four Chinese cruisers. The Chinese made one attempt to ram, and discharged one torpedo from a ship, and three from a boat. The attempt to ram resulted, it is claimed, in damaging, though not in destroying, the opponent attacked. The rammer herself was afterwards sunk, it was believed, by gun-fire. All the torpedoes discharged were ineffective. The Japanese tried to use neither the ram nor the torpedo. Besides the Chih Yuen, the Lai-Yuen and Chao Yung were sunk by shot, and the Yang Wei was run aground, to avoid foundering in deep water. The Japanese flagship Matsusima, which had taken her station in the center of her line, was so severely injured that Admiral Ito had to shift his flag to the Hasidate. The Hiyei was forced out of action for a time, and the armed packet steamer Saikio Maru had to go out of action altogether. The mast of the Akagi was shot away, and by its fall killed the captain and two men, all of whom were in the top.

The action lasted about four hours and a half, according to the Chinese, and fully an hour and a half more according to the Japanese. The battle of St. Vincent, it may be remarked, lasted from 11.31 A. M. till 3.52 P. M. or, if we include the "few comparatively harmless broadsides" exchanged by the Britannia and Orion with the Spanish lee division, till 4.50 P. M. —that is to say, less than five hours and a half. The First of June began at

9.24 A. M., the general firing ceased at 1.15 P. M., and the action was over at 2.30 P. M., having thus lasted just over five hours. The battle of Trafalgar was practically decided between noon and 2 P. M.; but the last of the captured ships struck just five hours after it began. These instances have been taken quite at random. The similarity of duration of these battles, differing so much in character, is not without interest. The Japanese left the scene of action, but returned the next day and fired a torpedo into the stranded Yang Wei. The victory was certainly theirs, though their disappearance from the scene and the unmolested withdrawal of the Chinese transports explain, if they do not justify, the Chinese assertion that it was they who had won the day, notwithstanding their losses.

The action was fought out entirely with guns. "The quick-firing guns gave the latter (the Japanese)," says the Chinese report, "an immense advantage, scattering showers of splinters, frequently setting the Chinese ships on fire, and riddling everything that was not protected." As an illustration of the greater chance of hitting that falls to the lighter guns, we have a statement of the number of shots fired from the heavy and from the 6-in. guns of the Chinese barbette ships. The eight 12-in. guns fired 197 rounds, or less than 25 a piece; the four 6-in. guns fired 268 rounds, or 67 a piece. The greater rapidity and accuracy of the Japanese fire—as was expected by those to whom the dominating effect of more rapid firing and more frequent hitting was known from historical record—afforded them more efficient protection than thick armor. The 12-in. armor of the Chinese barbette ships was intact; but their slightly protected 6-in. guns were also uninjured. From this it is difficult to see of what use the extra thickness of armor was. It would seem that it was never hit by an "armor-piercing shot;" and it supplies a useful practical illustration of the value of Sir George Clarke's suggestion ("Fortification," etc., p. 239), that the superficial extent of thick armor is so reduced in many so-called "armor-clads" that the protection given by it is due not so much to its impenetrability as to its small extent, which renders it unlikely to be hit.

The Chinese made a deliberate attempt to keep their bows turned towards the Japanese, in all probability in order to avail themselves of the highly-developed bow fire of their two barbette ships. The result of this action ought to be a warning to the confident people who advocate a heavy bow fire, to remember that all statistics of it should be accompanied by an estimate of the loss in broadside fire which must result from developing bow fire beyond certain limits.

Of top fire we have no reports. It would be interesting to know if its effect was neutralized by the long range at which, as a rule, the action was fought.

The total Japanese loss is officially reported as 77 killed and 160 wounded. Out of a crew in each case probably less than a fourth of the number of Japanese engaged, the Bellerophon had 49 killed 148 wounded, and the Majestic 50 killed and 143 wounded, at the Nile. At Trafalgar, out of a nearly similar crew, the Collossus had 40 killed and 160 wounded. Loss of life, at least on the part of victors, as also was shown at Lissa, therefore appears not likely to be as severe in modern sea-fights as in those of former days. The Matsusima, it is true, is reported to have lost two officers and 120 men killed and wounded. The proportions as given must make us doubt the accuracy of the figures; but it may be admitted that her loss was heavy, though less so than that of the British frigate Java in her action with the Constitution.

Superior rapidity and accuracy of fire bore the fruit which they have always borne in war, at any rate since the day when they brought about the defeat of the Invincible Armada. This superiority, as has always been the case, would have been barren of result had not the Japanese been sufficiently practiced in manœuvring at sea to enable them to avail themselves of its effect. As in all really decisive general actions, as far back as history can tell us about them, the battle was not won by fighting single ship against single ship, but by concentrating a larger number of ships—as has been previously shown—against a smaller.

Your obedient servant,

A NAVAL OFFICER.

THE NAVAL BATTLE OF HAIYANG.*

A JAPANESE ACCOUNT.†

On September 10, the Japanese squadrons left the temporary base of operations convoying 30 transports. Vice-Admiral Viscount Kabayama, Chief of the Naval General Staff was on board the Saikyo. As the day was the 220th day of the farmer's calendar, one of the most important days in rice cultivation, which has a direct influence on harvest prospects, the sea was not so calm as usual.

On the 14th the transports arrived at their destination in Caroline Bay, where the third flying squadron, consisting of the men-of-war Kongo, Takao, Yamato, Musashi, Katsuragi and Tenryu covered the landing of the troops. On the same evening the rest left for the Taidong river, where they arrived on the following morning. Here the Japanese admiral heard that the van of the army had already commenced the attack on Pingyang. The men-of-war Chokai, Maya, Tsukushi and Banjo were sent up the river to assist the army, while the main and the first flying squadrons anchored at Cape Shoppek. On the afternoon of the 16th the two squadrons, accompanied by the despatch boat Akagi and the merchant cruiser Saikyo-maru, weighed anchor to reconnoitre the Island of Haiyang and the mouth of the River Tayang. They had expected when they left the cape to meet the enemy, but did not by any means anticipate such a great battle as actually took place on the following day. They did not wait for the return of the torpedo-boats which had gone up the Taidong to assist the army.

On the 17th, at 6.30 A. M., the squadrons arrived off the island and the Akagi was ordered to reconnoitre the inlets of the island; but as there was nothing noticeable about the harbors, they advanced toward Talu Island, off Takooshan, a little past nine. Soon, however, cries of the enemy in sight were raised as streaks of smoke were seen to the ENE., that is, on the starboard bow of the squadron. At 11.40 the Chinese squadron came into sight. Admiral Ito signaled to the Akagi and Saikyo-maru to move to the left of the squadrons so as to be under cover. The Japanese men-of-war then made instant preparations for battle, the crew hastily finishing their meal.

At noon the Japanese fleet was 12 miles to the NE. by N. of Talu Island. Their actual position was 39 deg. 10 min. N. lat. and 123 deg. 5 min. E. long.

A report was received from the mast-head that the enemy's center was taken by the two largest ships. These were the famous Ting-yuen and Chen-yuen. The rest of the fleet were also the strongest of the Peiyang squadron.

The Japanese flying squadron advanced towards the enemy's center, but soon afterward veered to the left to assail the enemy's right. The main squadron underwent similar manœuvres. The Chinese came in a single irregular rank, and afterwards they formed a wedge with the great battleships at the apex. The Ting-yuen and Chen-yuen were in the center, next to them on either side were ships of the Lai-yuen and King-yuen type followed by the Ching-yuen and Chih-yuen, thus both wings being made of smaller vessels in the order of magnitude. The total strength of the Chinese was twelve. The two hostile squadrons were:—

On the Japanese side, the first flying or advance squadron, Yoshino,

*Sometimes referred to as the battle of the Yalu.

†The original account is accompanied by photographs actually taken from the Saikyo-maru when not engaged.

Takachiho, Naniwa, and Akitsushima, of which squadron the flagship was the Yoshino, commanded by Rear-Admiral Tsuboi; and the main squadron, Matsushima, Itsukushima, Hashidate, Chiyoda, Fuso, Hiyei, Akagi, Saikyo. The commander of the combined squadron was Vice-Admiral Ito, Commander of the Standing Squadron, who was on board the Matsushima.

On the Chinese side, Ting-yuen, Chen-yuen, Lai-yuen, Ping-yuen, Ching-yuen, Chih-yuen, King-yuen, Chao-yung, Yang-wei, Tsi-yuen, Kwang-chia, Kwang-ping. The flagship Ting-yuen was commanded by Admiral Ting-Joochang. The Kwang-ping and Ping-yuen separated from the squadron and went westward, while the remainder advanced in order. This was evidently to divert the attention of the Japanese and divide their strength; but while the Ting-yuen and Chen-yuen were in sight the Japanese hardly paid attention to the smaller vessels.

At 12.03 the Imperial Japanese naval flag was hoisted on the main mast as a signal for commencing the battle. Preparations for firing were made.

At 12.19 the Japanese admiral signaled that the men-of-war should fire when the enemy came within a suitable range. They were not to waste their powder. At 12.30 the flying squadron, which had been ordered to attack the enemy's right, advanced at the rate of ten knots an hour. At 12.45, when the hostile squadrons were at 6000 meters' distance from each other, the Chinese opened fire. The flying squadron then increased its speed to fourteen knots; and though it was exposed to incessant fire it continued to advance until it was at 3000 meters, when it replied for the first time at 1.05. The flying squadron directed especial attention to the Chao-yung and the Yang-wei, the two extreme vessels of the Chinese right wing. As these were seen to feel the deadly effects of the Japanese fire, the flying squadron continued to attack them until it was within 1600 meters of them. The Chao-yung caught fire and she listed to starboard. She sank soon after. The flying squadron, having now passed the Chinese squadron, veered at 1.20 sixteen points to port. It was then ordered to return to the main squadron.

In the meanwhile, as the main squadron advanced at ten knots to port of the enemy, and covering the two ships Akagi and Saikyo, the Hiyei, which could not maintain that speed, got far behind the rest; the Fuso, which brought up the rear, kept close to her. As the main squadron was passing the Chinese, the latter closed upon the Hiyei. The Ting-yuen and the Ping-yuen were within 700 meters, and poured broadsides upon her. The Chinese vessels were so close together that they began to be afraid of hitting each other, and stopped firing.

The commander of the Hiyei, fearing the enemy would ram her if she continued her course, boldly turned her prow towards the space between the Ting-yuen and King-yuen, and advanced. She was at one time only 500 metres from them. Two torpedoes were discharged at her, but they crossed her path only seven meters from her stern; and she escaped destruction. She fought with several of the enemy's ships and passing through them, returned to the main squadron. It was finely done. At this time the main squadron had passed the enemy, and changing the course to the right, manœuvred to get behind the enemy's squadron, which had now lost its line of battle.

Two more Chinese men-of-war, probably the Chen-nan and the Chen-chung, were seen at a distance; but they did not take part in the battle. There were also torpedo-boats; but they appear to have done little or nothing.

The Hiyei, which had escaped the torpedoes, was attacked by the King-yuen, whose shell struck the officers' room and killed a large number, including Chief Surgeon Miyake and Paymaster Ishizaka. The room was being used as a sick-room, and several patients were instantly killed. At 1.55 the Hiyei signaled that she was on fire. The Akagi, which now joined her had not fared any better. She had been ordered to keep up with the flagship; but being of low speed, she was soon left behind. She found herself alone when she saw the Lai-yuen and the rest of the Chinese left wing coming upon her, and already at 800 meters' distance. Her starboard guns attacked them severely and cleared the men off the Lai-yuen's bridge. At this time Lieut. Kosho Sasaki, captain of the first division, was wounded, and the cadet Kojiro Hashiguchi was killed. At 1.20, the enemy's ships, which continued to pursue her, killed Commander Hachiroda Sakamoto, the commander of the ship, and two gunners of the first quick-firing gun, while two others were wounded. Lieut. Tetsutaro Sato, chief navigating officer, took the commander's place and superintended the vessel. Just then the enemy's shells, which struck the lower deck, killed four firemen, wounded a fifth, and destroyed a steam-pipe, while another which struck the upper deck killed three gunners. When the Lai-yuen, Chih-yuen and Kwang-chia, after passing behind her, were again about to attack her, the despatch boat found the destruction of her steam-pipe completely cut off the supply of shells at the forecastle. Ammunition could only be obtained from aft by doing away with the ventilating shaft. The vessel was in the greatest straits, but as her course was changed to port, she was at some distance from the enemy, and the chief engineer, Teiichi Hirabe, and his staff succeeded in making temporary repairs, and her speed was not lowered to any great extent. Though she was not close to the enemy at the time, they were seen advancing towards her at full speed. She was obliged to change her course to the south, firing all the time from the stern to arrest the pursuit. The first quick-firing gun was managed by signal men. The enemy's shells knocked down her main-mast, and the ship's flag was taken down and reset upon the stump of the mast, which had been cut off. At 2.15 the Lai-yuen and others were about 300 meters behind her. A shot from the Lai-yuen again struck her bridge and wounded the navigating officer, who had taken the commander's place. At this time firing at the stern was strenuously kept up. Lieutenant Shuzo Matsuoka, the captain of the second division, took command of the ship, while the first-class marine Tayeji Shindo took the lieutenant's post at the guns. At 2.20 the Akagi's fourth gun at the stern struck the Lai-yuen's stern deck and caused a great fire there. The enemy's vessels slowed down to aid the Lai-yuen, and the Japanese were soon 700 or 800 meters away from them. At 2.23, as the navigating officer's wounds had been dressed, he resumed his post on the bridge, and relieved Lieutenant Matsuoka. At 2.30, as the enemy had been distanced, the marines were ordered to rest, and slowing down, the crew began to mend the steam-pipe. At 2.40 the roll was called, and after supplying vacancies, orders were given for rest.

When the Hiyei and the Akagi were hard pressed by the enemy the admiral signaled to the flying squadron to advance to their rescue. The Saikyo had got behind the flying squadron, as she found the Chih-yuen and the Kwang-ping coming towards her from fore and aft. But when the flying squadron turned to starboard at 2.20 to aid the Hiyei and the Akagi, she was confronted by the Chinese. A 30½-cm. shell from the Ting-yuen penetrated the Saikyo from behind the officers' room and destroyed the boiler connected with the steering gear. She signaled that

her steering-gear was damaged. She passed between the Akitsushima and the Naniwa, and coming upon the enemy's flank, met with a severe running fire. The relieving tackle was used, but difficulty was found in steering. The speed was lowered, but after fixing the hand-wheel, she advanced at full speed. At 2.23 the enemy's Yang-wei caught fire and was seen near Talu Island (probably stranded).

At 2.30 the Matsushima and the Ping-yuen commenced firing at each other at 2800 meters, and gradually approached until they were only 1200 meters from each other. At 2.34 the Ping-yuen's 26-cm. shell penetrated the Matsushima's officers' room and the central torpedo-room, killing four men at the portside discharger; and also exploded against the barbette. A shell, however, from the Japanese flagship disabled the Ping-yuen's 26-cm. gun. The Kwang-ping and a torpedo-boat then joined the Ping-yuen, and all three turned their attention upon the Saikyo. At 2.50 they were 3000 meters off on her starboard. She fired incessantly upon the torpedo-boat, which then steered for land. The Ping-yuen and the Kwang-ping exchanged shots with her at 500 meters. At 3.10 another torpedo-boat was seen ahead and advanced towards the Saikyo. When she was straight before her, the torpedo-boat discharged a torpedo from a tube at the bow, but it missed. Another discharged at 50 meters was equally ineffectual. They were most skilfully avoided by the Saikyo. The first came from the port bow and penetrated the water across the vessel, but as the Saikyo's speed was great, the torpedo exploded a long way off her path; and the second passed along the starboard side and exploded far behind. As the torpedo-boat had crossed the Saikyo's path between the two discharges, the directions of the torpedoes had intersected each other. At 3.30 the Saikyo steered southward and was from that time out of action. Her encounter with the Ping-yuen and Kwang-ping had been very severe. During that engagement she had received many shells, resulting in damages to the foremast and the first-class cabins below the quarterdeck. One of the shells had caused a fire in these cabins, which was only extinguished after some injuries had been inflicted. Though the ship was much damaged, the wounded were few, there being absolutely none killed.

Meanwhile, the first flying squadron, which had gone to the aid of the Hiyei and Akagi, had fired upon their assailants and, after passing them, steered to port. At 3.0 the Matsushima and the Yoshino faced each other on the starboard. The two Japanese squadrons had the enemy between them, and the fiercest encounter of the whole battle took place. A fire broke out on the flagship Ting-yuen, while her sister ship seemed disposed to retreat. The Japanese squadrons pressed on them until a shell of the Matsushima's great 32-cm. gun fell within 200 meters of the Yoshino's bow. They then went further apart to avoid each other's shells. At 3.30 the Chih-yuen was sunk; her starboard stern first listed, and she went down in five minutes amid cheers from the Japanese. About the same time, when the Matsushima faced the Ting-yuen, a shell from the Chinese flagship's 30½-cm. gun struck her barbette, and exploded on her heap of ammunition, by the explosion of which forty men were killed outright and as many wounded. The fourth gun was disabled.

The hull listed slightly. A fire broke out at the same time, but it was immediately put out. The survivors and band players were put to the guns. The hydraulic gear and valves were impaired and the 32-cm. gun was disabled. Commander Mukoyama, the Vice-Commander of the flagship, has expressed his high admiration of the marines on board, especially their increased energy and courage when forty of their comrades had

been slain. As an instance of their gallantry on this trying occasion, the following has been reported: The shell which played such havoc on board burst on the lower deck, and the whole place was covered with smoke. The magazine just below was in imminent danger, as it was feared that it would catch fire and explode. A first-class sergeant and a fourth-class marine in charge of the magazine were in peril of their lives. In spite of others' warning they still kept their stand, resolved to die at their post. The fiery smoke of the exploded shell threatened to invade the magazine through crevices; and all feared the magazine would immediately catch fire. But the two men in charge instantly stripped themselves and crammed in their clothes wherever they thought the fire would obtain ingress. By their prompt action the magazine was saved and the Matsushima escaped a most serious danger.

During the fire on the Ting-yuen, the Chen-yuen, which never left her side, ably aided and covered her. It was due to the Chen-yuen's skilful manœuvres that the Chinese flagship did not suffer more. On these two great battleships the Japanese main squadron exerted its utmost. Its shells at 3000 meters could not penetrate the battleship's 14-inch armor. The first flying squadron went in pursuit of the Tsi-yuen and the rest of the Chinese squadron, which began to fly in the direction opposite to that of the battleships. The Lai-yuen caught fire; and seeing her sorry plight the flying squadron pressed on her sister-ship King-yuen which was still active. At 3.52, when she was 3100 meters to the north, the Takachiho fired at her; and when at from 2300 to 2500 meters the Yoshino opened on the vessel her three 15-cm. automatic quick-firing guns at the bow, until she was 1800 meters off. They told with deadly effect. At 4.48 the King-yuen listed to starboard, and two fires suddenly broke out at the stern and amidships. The waterline became visible on the port side, and the rudder becoming useless, the vessel described swift but aimless curves. The stern then dipped deep in water and after an explosion—probably the bursting of her boilers—amid a thick volume of black smoke, the King-yuen disappeared altogether. This was a unique case of a battleship being sunk by a cruiser; and it was no doubt due to the efficiency of the Yoshino's new quick-firing guns and of the cordite she had used.

It was now close on sunset. The flying squadron was recalled. The Akagi, whose damaged steam-pipe had at length been mended, joined the main squadron at 5.50. Both the Saikyo and the Hiyei had gone back to the base of operations. The Matsushima was sent to the Japanese admiralty port of Kure, while the admiral's flag was transferred to her sister-ship Hashidate. As the Chinese torpedo-boats had joined the Chen-yuen and Ting-yuen, a night engagement would have been disadvantageous to the Japanese. They, therefore, followed them at a distance. The Ting-yuen's fire was at length extinguished. The Japanese decided to wait till morning and intercept the enemy on their way to Wei-hai-wei, whither they appeared to be bound. They cautiously advanced towards that port, but at dawn failed to get a glimpse of the enemy.

Early on the 18th the squadrons returned to the scene of the previous day's battle. The Yang-wei, which was seen stranded was destroyed with a torpedo from the Chiyoda. The Akagi was ordered in the morning to return to the temporary base of operations, whither the Japanese squadrons also returned safely on the following morning. Fuel, provisions and ammunition were taken on board; and preparations were made for another engagement, should the enemy offer a second opportunity. Then the Naniwa and the Akitshusima were sent westward to reconnoitre Wei-hai-wei, Chefoo and Port Arthur. The enemy's warships, fearing another

attack, had apparently concealed themselves in harbors, for they were not to be seen. As the defenses of Port Arthur were very strict, a complete reconnoitre of that port could not be effected; but the enemy's squadron appeared to be ensconced within. At the mouth of Talien Bay the scouts saw two of the enemy's men-of-war. One of them, which was probably the Tsi-yuen, hurriedly fled into harbor as soon as she saw the Japanese ships, but the other, Kwang-chia, of the Fuhkien squadron, had apparently run ashore in trying to escape from the naval battle. As she was, therefore, unable to move, her crew, fearing her falling into the hands of the Japanese, exploded and destroyed her. The quickness with which this destruction was effected certainly deserves praise.

The news of this naval battle was received with unbounded enthusiasm in Japan; and H. M. the Emperor of Japan sent the following congratulatory message to Vice-Admiral Ito, commander of the combined squadrons: "We hear that our combined squadrons fought bravely in the Yellow Sea and obtained a great victory, and perceive that their power will command the enemy's seas. And deeply appreciating the services of our officers and men, we are delighted with the extraordinary results they have obtained."

Soon after, Commander Saito, the Naval Chamberlain, was also sent to the squadron to convey his majesty's congratulations and to give a full report on the memorable battle.

Among the Japanese men-of-war the most damaged were the Matsushima and the Hiyei. The Matsushima had received on her gun-deck two 30½-cm. shells, one of which penetrated from one side to the other and fell into the sea, while the other exploded in the ship and, by setting fire to the powder, caused a conflagration. Over 80 were killed or wounded. The 30½-cm. shell with which the Hiyei was struck, penetrating one side, exploded on the lower deck, destroying the after mast and causing a fire. Several men were killed or wounded.

The principal damages done to the Japanese men-of-war were as follows:

Matsushima.—Besides the two shells just mentioned, one 26-cm. shell penetrated the torpedo-room, and another struck a Hotchkiss quick-firing gun.

Hiyei.—Besides the one above mentioned, a shell on upper deck killed gunners.

Naniwa.—A shell near water-line. An explosion in the coal bunker, but without any serious damage.

Chiyoda.—A shell above water-line penetrated the hull.

Itsukushima.—A shell in torpedo-room; another half-way up the mast, and a third in the engine-room.

Hashidate.—A 15-cm. shell exploded against the 32-cm. gun barbette.

Akagi.—A shell on topmast, and another on bridge, killing the commander.

Saikyo.—Received many shells, but the most dangerous was the one which struck the first-class cabins. If it had struck ten feet forward the engine-room would have been destroyed and the ship would have lost control. She was certainly terribly damaged; and one of the most remarkable lessons of the battle is the amount of injuries a lightly-armed passenger steamer can bear without sinking. The shells which struck her were the following:

Kind of Shell.	No.	Damaged.
30.5-cm.,	4	Mainmast and piano-room.
21.0-cm.,	1	Mainmast and piano-room.
15.0-cm.,	2	Quarterdeck and port davit.
12.0-cm.,	1	Between mainmast and engine-room.
12.0-cm.,	1	Exploded near a rudder on stern main deck.
12.0-cm.,	1	Foremast derrick.
12.0-cm.,	1	Funnel.
6-lbs. and less,		Over 10.

The 12-cm. shell which exploded near the rudder on the stern main deck struck against the staunchions and its pieces set fire to the clothes store. But the fire was extinguished. Though the Saikyo was thus severely damaged, the enemy's shells missed her vital parts and the vessel was enabled to arrive at Ushina without further mishap.

When the Akagi and Hiyei arrived at Nagasaki previously to their going in dock for repairs, the Nagasaki *Rising Sun* newspaper gave the following description of their damages: Judging by the outward appearance of the Hiyei and Akagi, which are said to have borne the brunt of the fight, in company with the Matsushima, much cannot be said in favor of Chinese marksmanship, if that is the best their gunners can do in a comparatively close range engagement lasting about five hours. The Hiyei has a large, round shot hole in her stern, three smaller splintered holes amidships on the port side, and one on the starboard side. The Akagi has lost her mainmast, the falling of which is said to have caused the death of her commander, her funnel is badly riddled, and there are several shot holes abreast of the mainmast on the starboard side.

The Matsushima's losses were heavy. Two officers and 49 sub-officers and men were killed, while an officer and 40 sub-officers and men were wounded; thus out of a complement of 360 men, no fewer than 92 were *hors de combat*. Of the wounded, 29 had been injured by fire, and two died since entering hospital. The Hiyei lost 3 officers and 14 sub-officers and men killed and 16 wounded. The Akagi's killed numbered 11, including the commander, and her wounded 17. The Itsukushima's killed were 13; the Yoshino's 10; the Akitsushima's and the Fuso's 4 each, and the Hashidate's and Takachiho's 1 each, making the total number 115, of whom 10 were officers. The total number of wounded sent into hospital was 103, those who were treated in their own vessels not being counted.

All the wounded were expected to recover except some ten of them.

The Naval Chamberlain's report gives the following as the damages to the Chinese squadron:

The Chao-yung received great injuries from the Japanese shells, and was unable to move freely. A fire broke out in the vessel, which was soon enveloped in flames and finally sank.

The Yang-wei was greatly injured by the Japanese shells, and a fire broke out on board, but she managed to move about until she was stranded. According to the report of the Chiyoda, which was sent to examine her, there were 15 marks of shells upwards of 12-cm., four feet or more below the upper deck on the port side amidships. On the upper deck the marks were innumerable; but the fire had so confused the marks that it was impossible to count them. The honey-combed condition of the ventilator, brought back to Hiroshima, proves that many shells had taken effect.

The Chih-yuen's condition was much like the Chao-yung's. She heeled to starboard and sank. Her screws were seen to revolve out of water.

The King-yuen was first attacked by the Yoshino, whose shells were so effective that the ship listed forward on the port side. The rest of the first flying squadron, that is, the Takachiho, Akitsushima and Naniwa followed and attacked her so severely that a great fire broke out on board. A large volume of smoke arose; and the vessel moved sometimes to the starboard and sometimes to the port. She was evidently unable to steer. Afterwards the vessel listed to starboard, and finally, showing her keel, sank.

The Ting-yuen had the whole of her barbette on fire through the Japanese shells, and the smoke enveloped the whole vessel. She was just able to move. The fire lasted two hours. When the battle was but half over the 15-cm. gun on the stern was the only one she could fire. During the fight the mainmast was broken in two and the admiral's flag fell. It was not seen hoisted again.

The Lai-yuen was also set on fire by the Japanese shells. The smoke covered the after half of the ship, and the fire lasted an hour and a half. She did not, however, lose freedom of movement. The fire was produced by the Akagi's stern gun when that vessel was hard beset by the Chinese.

The Chen-yuen: when the five vessels, excluding the Hiyei, of the Japanese main squadron, fought with the Ting-yuen and the Chen-yuen, the first flying squadron had gone in pursuit of the enemy's war ships which had taken to flight, and was therefore separated from the main squadron. It is asserted that the Chen-yuen skilfully covered the flagship Ting-yuen, which was almost unable to move on account of the fire. The Chen-yuen continued firing till the end of the battle.

The Ching-yuen, Ping-yuen and Kwang-ping took to flight. Though no damages were noticed on their exterior, they appeared on the whole unable to fire their principal guns.

The Tsi-yuen fled far away from the commencement of the battle. As she was only exposed to a short attack from the Naniwa, she probably received but little damage. The Tsi-yuen did not from the first fire her principal guns.

The Kwang-chia, when fleeing from the fight, struck on a dangerous reef outside Talienwan. On September 23 the Naniwa and Akitsushima, when reconnoitring, were seen coming and the vessel was destroyed by its own explosion. At low tide, several feet of the hull is still to be seen; two masts have fallen, only the mainmast stands at present.

The Chen-nan and the Chen-chung kept at a distance with the torpedo-boats and did not engage in the fight. They were, therefore, probably uninjured.

DIAGRAMS SHOWING THE MOVEMENTS OF THE HOSTILE SQUADRONS.

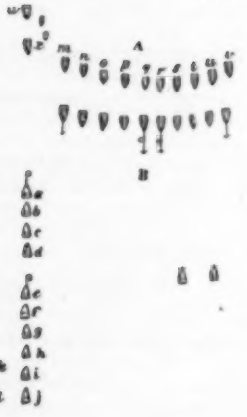
In the accompanying diagrams the positions and movements of the hostile squadrons are shown.

In the map of the Corean Sea, the route of the first flying squadron is given, together with the approximate points at which the Chinese men-of-war were sunk.

The abbreviations used in the diagrams are the following:

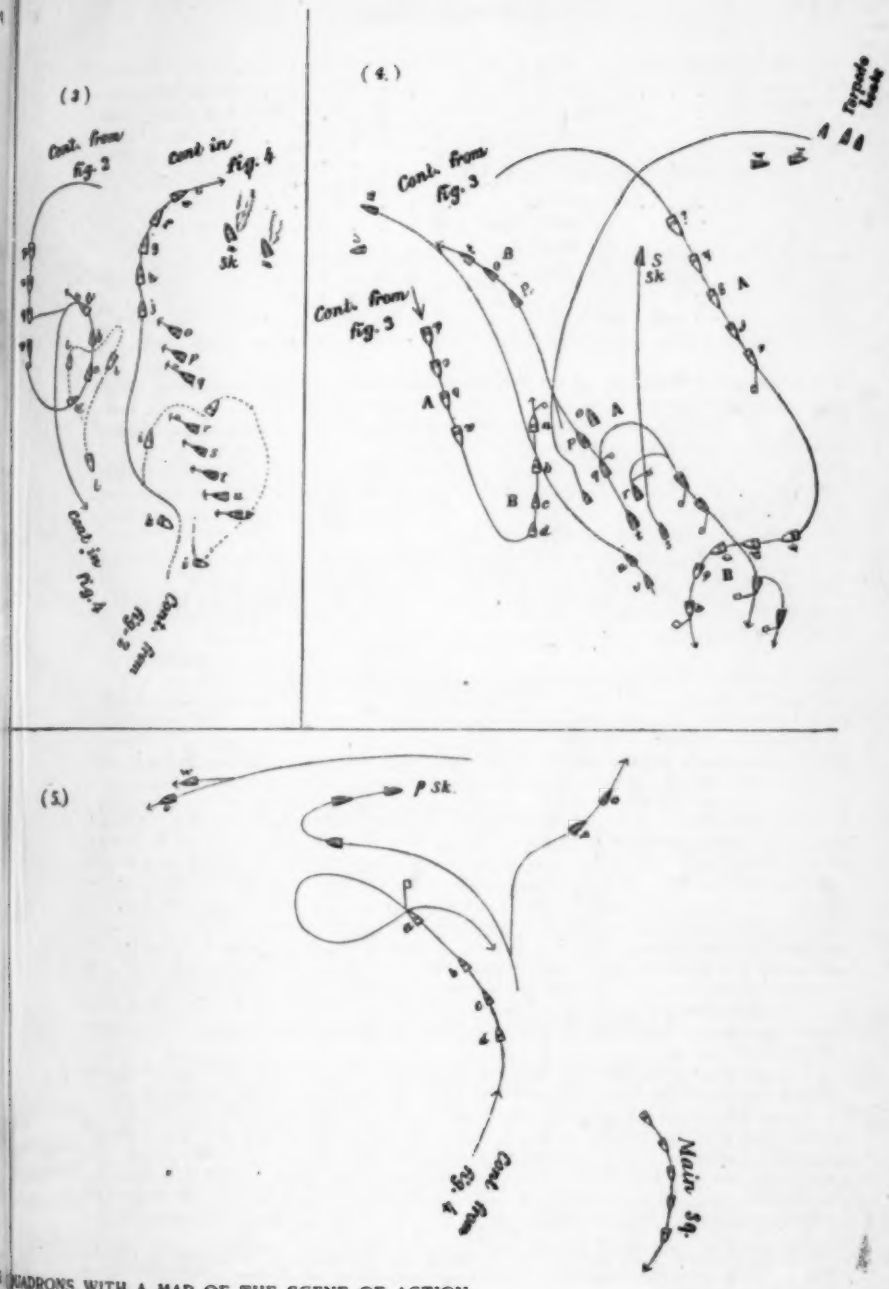
The ships with only two strokes are Japanese, while the Chinese are all shaded.

(1.)



(2.)

DIAGRAMS SHOWING THE MOVEMENTS OF THE SQUADRON



F THE QUADRONS WITH A MAP OF THE SCENE OF ACTION.

Japanese.		Chinese.	
a	Yoshino.	*m*	Chao-yuen.
b	Takachiho.	*n*	Yang-wei.
c	Akitsushima.	*o*	Lai-yuen.
d	Naniwa.	*p*	King-yuen.
e	Matsushima.	*q*	Ting-yuen.
f	Chiyoda.	*r*	Chen-yuen.
g	Itsukushima.	*s*	Chih-yuen.
h	Hashidate.	*t*	Ching-yuen.
i	Hiyei.	*u*	Kwang-ping.
j	Fuso.	*v*	Tsi-yuen.
k	Akagi.	*w*	Kwang-chia.
l	Saikyo.	*x*	Ping-yuen.

Sk. stands for sunk. A and B are the two positions assumed by the squadrons.

Fig. 1. The position at 12.45, when the squadrons are approaching and the Chinese have begun to fire.

Fig. 2. At 1.20, when the flying squadron (in B) is veering 16 points to port.

Fig. 3. The flying squadron, after being called back to the main squadron, has started again at 2.20 to the aid of the Hiyei and Akagi, leaving the Saikyo exposed to the Chinese fire.

Fig. 4. The main squadron attacks the two great battleships, while the flying squadron goes in pursuit of the rest of the Chinese fleet.*

Fig. 5. The flying squadron is called back after sinking the King-yuen.

FACE HARDENED ARMOR.

By Captain W. T. Sampson, U. S. N.

[*Extracts from a paper read before the American Society of Naval Architects and Marine Engineers.*]

The difficulty of securing structures to the hard face, in default of knowledge as to the exact location of the fastenings, is also in course of solution. It was found feasible to tap and drill holes in the face of the plate at any stage of the process prior to hardening without detracting from the plate's resistance; but, as it was impossible to locate these holes with precision without fitting the armor into place, this method was abandoned in favor of one by which the carbon was prevented from penetrating over certain areas in the wake of the fastenings. This method also had its disadvantages in that the carbon gases frequently seeped through the protecting material and carbonized the surface beneath. The most satisfactory method, and one which will probably be employed in the future, is that of electrically annealing the surface to be drilled.

The greatest objection to the face hardening or Harvey process, and one which seems least likely to be overcome in the immediate future, is its expense. The thickest plates are exposed to high temperatures for weeks at a time, and the charges for repairs, fuel and labor are very great. It seems possible, however, that means may yet be determined for shortening this stage of the process and reducing somewhat the temperature required for cementation. The repeated machining, however, can hardly be dispensed with; shrinkage and distortion occur not only in the hardening, but in the

*The figures are reproduced from those furnished, but a typographical error evidently exists in Fig. 4. In the lower right hand corner the five vessels attacking the Chinese battleships should be lettered *e*, *f*, *g*, *h* and *i*.

cementation as well. Plates must be at least approximately machined before cementation; they must then be shaped and machined to such dimensions as experience has taught will, after hardening, be satisfactory. Even then it may be necessary to anneal, machine, and retemper, before obtaining satisfactory results. These difficulties of the manufacturer, although reduced by skill and experience to the minimum, are likely to remain permanent.

THE EFFECT OF NICKEL.

The decision of the Armor Board of 1890 that the Schneider nickel steel plate was softer than that of steel, and allowed greater penetration, was correct for those two plates. Our armor makers, however, have had no difficulty in making oil tempered nickel steel armor far stronger and more resisting than that of simple steel, while it still retained the characteristic toughness of the nickel.

The susceptibility of nickel steel to treatment is remarkable, and yet this steel may be abused in the most shameful way without failure. For this reason the smaller percentage of losses in manufacture will go far toward wiping out the increased cost of machining the tougher material. Nickel appears to render the carbon more sensitive to hardening, and hence water hardened Harvey plates of nickel steel are toughened at depths hardly affected in simple steel plates. Not only that, but the hardening is accomplished with less risk to the plate, and it is for this reason that the manufacturers of the Loire have been able to forego entirely oil-tempering armor plates and obtain the increased resistance due to the more severe operation of water hardening. There is, therefore, nothing in the present application of the Harvey process, nor its future possibilities, to indicate the disuse of nickel in armor; rather that by increasing its percentage the toughness of the foundation plate and its resistance as a whole may be increased.

The service test for Harveyed plates for United States naval vessels require them to withstand two shots, the first delivered with the velocity which, according to the Gâvre formula, would cause the perforation of a wrought iron plate 10 per cent. greater in thickness, together with 36 inches of oak backing, the requirements being that no crack shall extend from the impact to the edge, or from one edge to another of the plate, and at the same time through the entire thickness of the plate at an edge. The second shot is at the velocity which, according to the De Marre formula, would cause the perforation of a Creusot steel plate 15 per cent. greater in thickness, together with 36 inches of oak backing, the requirement in this instance being that the projectile, or any fragment thereof, shall not pass entirely through the plate and backing.

These tests are but 15 per cent. more severe than those required for oil tempered nickel steel plates, and are now 3 per cent. less severe than those fixed by the latest contracts in France. It has been claimed that the larger calibers employed in France make the test more severe. This is hardly the case, as in France cracking is not barred.

It would thus seem that the minimum requirement in France, after all, is hardly as severe as our own; still there are three grades of quality and three prices under the same contract. It must be remembered, however, that the tests in the United States do not, as abroad, fix a standard of excellence. They mark the inferior limit, as does the last shot mentioned in the French contract above. The poorest, not the average, plate in an armor group of from 300 to 500 tons must pass this test or the entire lot is rejected. With the careful inspection of the various delicate operations of manufacture, aided by physical and chemical tests, it has been possible for the inspectors to select a Harveyed plate believed in every instance to be less resisting than any other in the group. Our service plates must, therefore, be regarded as generally exceeding the resistance of the plates tested by a considerable amount.

In the United States the necessity of developing the manufacture of armor has prohibited active competition. It was necessary to place orders and formulate specifications before practical business men could be induced to erect the required expensive plants, hence it was necessary at first to borrow largely from experience abroad. In England and on the Continent, where the armor manufacturers were, at the advent of the Harvey process, provided with plants in which the equipment had followed step by step the advance of the art, contracts are awarded to the firms producing the best material, so that an active competition exists.

In England about 20,000 tons of armor of this description have been ordered, the latest contract being for 12,500 tons, intended for the barbettes and citadels of the first-class battleships Prince George, Hannibal, Victorious, Jupiter, and Mars. Harveyed armor is now being manufactured for the battleships Renown, Majestic, and Magnificent in England, the St. Louis and Charlemagne in France, one Danish vessel and two Japanese.

The great English firms of Cammell, Brown and Vickers are all provided with Harveying plants. In France, St. Chamond, Chatillon Commentry, Marrel Frères, and St. Etienne have adopted the process, the first three accepting contracts to furnish plates up to a thickness of 15.75 inches, St. Etienne making plates under 8 inches in thickness. Schneider & Co. have also acquired the process, as well as the firms of Krupp, Dillengen, and Witkowitz, all of whom had previously employed special face hardening processes of their own.

Certain French authorities place the resistance of Harveyed plates at about 1.35 that of simple steel, or 1.80 that of iron. English authorities regard the results of the trial of a 6-inch Harveyed plate as indicating a superiority, when compared with iron, of 1.83. Another French authority states his belief that good Harveyed plates are able to keep out projectiles whose caliber equals their thickness at velocities of from 1968 feet to 2132 feet. American plates compare very favorably with these estimates, Carnegie 6-inch plates having kept out 6-inch projectiles with velocities up to 2110 feet s., exhibiting a resistance, as compared with iron, of 1.93; while a Bethlehem 8-inch plate kept out an 8-inch projectile with a velocity of 2004 feet s., showing a resistance 2.14 times that of iron.

It is difficult to explain some of the errors of an essayist in the Journal *Le Génie Civil* of August last, who confuses the trials of our homogeneous oil tempered and Harveyed plates and calls attention to the low velocity with which the former are attacked in comparison with those employed against face hardened armor abroad. There are many other errors unfavorable to American armor in this essay, which are all the more remarkable as the press of this country, invariably well informed, has correctly reported the trials in every instance.

It is still more difficult to exercise forbearance when, in discussing actual Harveyed plates, he gives undue attention to plates acknowledged to be radically defective.

Surface cracks occur frequently in the thinner Harvey plates, owing to the rapidity with which local cooling takes place in bending or rectifying, and the limited range of temperatures between which the carbonized surface can follow the tougher and more extensible back. In all of the tests it was found that defects confined to the hardened surface in no case initiate, give direction nor extension to cracks produced by impact. In this respect the conclusion reached is identical with that arrived at in the case of the surface chill cracks of Grûson chilled iron armor. In fact, it has been proposed, by artificially creating such cracks or openings and enlargements of the surface, to expedite and control the depth of cementation, deepen the chill in hardening, and limit the flaking under impact.

There is strong reason to believe that in the latest tests made in this country with capped shell the quality of the projectile had more to do with its success than the presence of the cap, as in two instances the point of the pro-

jectile was either broken off or mashed in. In all cases, however, the action of the hard, inextensible face surrounding the head of the entering projectile is plainly shown in the spiral scores and grooves cut on the ogival of a shot which has perforated a Harveyed plate. When, therefore, we are shown the photographs of French and Russian shells which have either perforated or rebounded after penetrating a Harveyed plate, without exhibiting a sign of a scratch, we are compelled to state, in the light of past experience, that the plate was not a good type plate, being too soft, and tough rather than hard.

The theory has been advanced, however, that with the improvement of projectiles—not necessarily capped, as that feature can hardly be regarded as practical and serviceable—the Harveyed plate will lose its peculiar advantage now due to its smashing the projectile, and will become really less resisting than a homogeneous plate of equal thickness, on account of the softer body and back of the Harveyed plate. This argument is fallacious; the principle of a non-homogeneous hardened face, combined with a decrementally toughened body and back, is correct. The homogeneous plate, as compared with the non-homogeneous, must always be perforated in detail. Should the homogeneous plate of the future be greatly superior to the face hardened plate of to-day, it will be made still more resisting by employing it as the foundation plate to which the process of face hardening is applied.

Whatever conclusion is reached, the fact remains that Harveying in its present state has increased the resistance of armor fully 35 per cent. and perhaps 50 per cent., according to the thickness of the plate. It has also brought about a great improvement in the quality of our projectiles, and in doing so has perhaps lost some of the advantage it held over them at first, when subjected to direct impact. Its superiority under inclined impact is nearly as great as it ever was, and it does not seem possible that in this respect the relation between gun and armor will for a long time to come take the old position held in the time of soft armor. Perhaps this relation may be restored, however, should the thickness of armor be reduced to a point allowing no more than the old resistance, in order to distribute it over a larger area or divert the weight thus saved to other uses.

THE GULF STREAM.

By Lieutenant-Commander JOHN E. PILLSBURY, U. S. Navy.

[*Hydrographic Office Publication.*]

In order to explain the action of the Gulf Stream it is necessary briefly to enter the subject of its causes. Every navigator of its waters knows that at times it is stronger than at others, and that under the same apparent conditions of wind and weather the stream is variable in velocity and direction.

The greater regular variations are chiefly due to changes in the position of the moon—a daily variation governed by its time of transit, and a monthly variation following the changes in declination. Both of these can be predicted with considerable precision.

The unusual variations come from the force and direction of the wind and the difference in the height of the barometer within and without the Gulf of Mexico. A knowledge of the action of these forces and the way by which they tend to produce the unusual changes will enable the navigator to take advantage of immediate conditions and so shorten his passage from port to port.

The cause of the Gulf Stream, and of most ocean currents, is directly or indirectly due to wind. Every wind produces a slight movement of the water over which it blows, by its friction on the particles of the surface water. As the upper particles acquire a movement the same motion is transmitted to the lower particles, thus forming a current. Although every wind causes a current, it is only persistent or long continued wind from the same general direc-

tion that produces a current of sufficient volume to become permanent or to be felt for a considerable time after the wind has ceased. A strong gale may cause a current of half a knot, but its blow is of short duration and the current is shallow and consequently of but little volume. With the trades, predominating as they do from the eastward, and persistently blowing over a large area, the current set up extends to 70 or 80 fathoms depth, which maintains its average velocity in spite of the daily variation in its producing cause.

Any current, upon meeting an obstruction, must escape in some direction. The current from the southeast trades reaches the South America coast in the vicinity of Cape St. Roque, and it thereupon divides into two branches, one flowing to the southward, along the coast of Brazil, and the other toward the West Indies. The current from the northeast trades, flowing in the general direction of the wind, meets the obstruction of the coast of South America and of the Windward Islands. The combined currents have a partial relief by an escape through the passages of the Windward Islands, while the remainder passes along the northern side of the West Indian Islands toward the coast of the United States. The current entering the Caribbean is driven to the westward until it meets the obstruction of the coast of Honduras. Here the escape is in two directions, a part flowing to the southward and a portion toward the Straits of Yucatan.

There is another movement of the water which is more effective in producing a current along shore, and which probably contributes as much water to form the Gulf Stream as the surface current due to the friction of the wind. This is the water driven to leeward by the break of the waves. A gentle wind makes a small wave which breaks in a ripple and by so doing throws a small quantity of water in its direction. A strong wind makes a larger wave, and in a gale every break throws tons of water to leeward. Where the wind is blowing in the same direction over a large area, like the Caribbean Sea, the effect is a simultaneous movement of the surface towards the lee shore. In the case of the Caribbean, a strong shore current is produced toward the Straits of Yucatan and to the southward along the Mosquito coast. It is from this cause that violent shore currents are set up along the coast of Cape Cod, New Jersey, and North Carolina in northeast gales. The waves are thrown toward the shore, from which the escape of the water makes the strong current that has wrecked many a vessel.

The irregularities of the Gulf Stream due to the varying wind can not be predicted except in the most general way. An increase or decrease of the force of the trades is not felt at all, except at intervals of seasons, because the force of the current is the result of average conditions, and a temporary abnormally strong wind in the trade region will not materially change the average. The first part of a norther in the Gulf of Mexico will probably cause a strong Stream current, because the water is driven toward the Cuban shore, from which it escapes through the Straits of Florida, causing the strong current. A wind blowing across the Stream does not change the position of the current. It simply throws the heated water by the break of the waves, and transports it by friction beyond the usual limits, but the current of the Stream holds to its fixed position. The presence of Gulf weed is in no way a sure indication of current, for it is carried more by the waves than by the current. A wind blowing across the Stream may carry every particle of weed into the outside waters. It has been observed that Gulf weed is found well up toward Nantucket Shoals. A long continued southerly wind will, by the break of the waves, transport the weed into this locality, which is 150 or 200 miles from the current of the Stream.

The barometer is a fruitful source of abnormal variations in current in the Straits of Florida, but it is doubtful if much of its effect is experienced in the Atlantic. A high barometer in the Gulf of Mexico, accompanied by a lower barometer in the Atlantic, causes a greater outflow in the Straits, and with the reverse barometric conditions, a weaker flow. The first influence of the

difference in pressure is felt on the sides of the Stream, where the normal current is weakest. Ordinarily there is a neutral zone of current, beginning at "The Elbow" near Carysfort Reef lighthouse and extending to Tortugas, in which the current is variable. With a high barometer in the Gulf the current in this zone may be steadily eastward, and, if the same conditions are of long duration, the effect of the barometer may be felt throughout the Stream. A navigator approaching Tortugas from the westward, and having a high barometer, may expect a favorable current skirting the Florida Reefs, and consequently need not lay a course so far off shore in rounding the Peninsula. Bound to the southward, and approaching the Straits of Florida with a low barometer in the Atlantic, the closer aboard the reefs are held the less will be the current found.

The above constitute the irregular and unusual variations of the Gulf Stream. The usual and normal current is subject to variations in velocity and somewhat also in direction, but these changes can be predicted with accuracy, and the position of the axis from off Habana to Hatteras is known. The average velocity is greatest at the axis, which is rarely in the middle of the current. Off Habana it is south of the middle, or nearest the Cuban shore, but off Fowey Rocks and Cape Florida, and from thence to Cape Hatteras, it is west of the middle. The position of the axis under average conditions is given below:

East of Contoy Island, Yucatan	35 miles.
North of Habana	25 "
East of Fowey Rocks, Florida	11 "
East of Jupiter lighthouse, Florida	19 "
Southeast of Cape Hatteras lighthouse, North Carolina, about	38 "

From Jupiter lighthouse to Cape Hatteras, about 16 miles outside the curve of 100 fathoms, disregarding the irregularities of the curve.

The positions here given are the points at which a strong current is surely to be found. Two or three days after the lowest declination of the moon, it is considerably stronger than at any other part of the Stream. As the moon approaches its greatest declination, north or south, the current at the axis lessens in velocity and at the same time the current increases in speed on either side of it. In other words, the highest current after low declination has a narrow front but a great velocity. The narrow front gradually widens as the position of the moon changes, the velocity increasing on the sides as it spreads and diminishing in the axis. Advantage may be taken of this variation in laying a course when rounding the bend of the Straits of Florida. After low declination of the moon the strength of the current off Fowey Rocks is 11 miles off shore, but after high declination a vessel will find almost the same velocity at 6 or 7 miles distant.

There is a daily variation in velocity amounting at times to over 2 knots. The maximum current arrives each day as follows: In the Straits of Yucatan ten hours before the upper transit of the moon. Off Habana 9 hours 24 minutes before, and off Fowey Rocks at 9 hours. There is another increase in speed at about the same time before the lower transit but it is usually very small and not well marked. The master of a vessel bound south, and crossing the Stream in the Straits of Florida will make the best passage if he starts across so as to reach the axis three or four hours before the lower meridian passage of the moon, for at this time the current is the weakest. Particularly is this advisable just after the highest declination of the moon, when the strong current of the axis has spread out and extends farthest toward the Florida shore.

The characteristics of the different parts of the Gulf Stream from the Caribbean to Cape Hatteras are as follows:

In the Straits of Yucatan the main flow of the current into the Gulf of Mexico

is on the west side of the Strait, the greatest velocity being from 25 to 45 miles from Contoy Islands, Yucatan. On the east side, within 20 or 30 miles from Cape San Antonio, there is a variable zone in which the current after high declination of the moon is an eddy setting into the Caribbean, and after low declination into the Straits of Florida.

Across the Mouth of the Straits of Florida, on a line 60 miles to the eastward of the meridian of Cape San Antonio, this same eddy current is experienced, that is, along the Cuban shore it sets toward the Caribbean after high declination of the moon and toward Habana after the low declination. The main strength of the current in this section is on the northern side 20 or 30 miles outside the 100-fathom curve at which point the flow at all times is toward the southern side of the Strait or toward the position of the axis off Habana.

Between Key West and Habana the current is variable on the northern side for a distance of 20 or 25 miles. This is a part of the neutral zone mentioned already as beginning about "The Elbow" near Carysfort Reef lighthouse and gradually widening as the longitude increases. Its width varies under normal conditions of barometer, etc,, it being narrow after high declination and broad after low declination of the moon. Under former conditions, the strength of the current having a broad front, it extends farther to the northward and, encroaching on the neutral zone, lessens its width.

A vessel crossing between Key West and Habana under average conditions will make a course good from port to port by allowing $1\frac{1}{10}$ knots per hour of passage.

Off Fowey Rocks Lighthouse the axis is about 11 miles distant, but after high declination of the moon a strong current will be found 6 or 7 miles off shore; at this time therefore, when bound north, it is not advisable to run off shore as far as the axis in rounding the reefs, for the little advantage gained by the difference of current will be more than offset by the greater distance traveled. After low declination, however, a vessel should not pass Fowey Rocks nearer than 10 miles. From either position, a course laid to pass Jupiter lighthouse about 19 miles distance will strike the strongest current off that light.

Crossing the Stream from Gun Cay to Fowey Rocks an allowance of $2\frac{1}{4}$ knots per hour is a fair average to make the course good.

Off Cape Hatteras it is generally believed that the thermometer is a sure indication of the Gulf Stream and that the strongest current coincides with the highest temperature. This is not the fact however. The warm water only indicates its tropical origin and may or may not be accompanied by a current. The warmest water southeast of the Cape is the result of a very gentle flow coming from the trade region outside the West Indian Islands. The Gulf Stream itself is between this warm water and the 100-fathom curve.

Starting from Hatteras Shoals the first marked rise in temperature is found in the vicinity of the 100-fathom curve. About 40 miles farther off shore there is a sharp fall followed by a rise which reaches its maximum about 75 miles from the Cape. The strong current is to the northward and westward of the sharp fall in temperature. Although it leaves the tropics at about the same temperature as the water coming by the outside route, its more rapid flow and its slight daily variations in direction cause an intermingling of the surface and lower waters, so that by the the time Hatteras is reached it is cooler than the water of the more gentle outside flow.

It is difficult to determine with certainty when the current is reached by the thermometer. All observations taken at anchor for a distance of over 60 miles from the 100-fathom curve indicate that the Stream has the same regular laws as are found in the Straits of Florida. That is, after high declination of the moon the stronger current is broad and extends nearest the 100-fathom curve at which time the first rise in temperature vill probably be accompanied by a northeast current. After low declination, on the other hand, when the axis is more narrow, the first rise in temperature will be with a current flowing in the opposite direction. It is thought, however, that the width of this eddy current is narrow.

Vessels bound from ports to the northward of Hatteras to ports in the Straits of Florida or in the Gulf of Mexico will save time by crossing the Stream at the Cape. An allowance of 1 ½ knots per hour of passage is a fair average to make a course good, remembering that the Stream is about 40 miles in width from the 100-fathom curve, and that its outer edge is about parallel with the curve at this point.

Outside the Stream no allowance can be given, but the current is usually very weak on a course to Mantanilla Reef (near the northwest corner of Little Bahama Bank) or toward Abaco and the Hole in the Wall. Steamers taking the former course had best run down the Stream on the east side as far as Gun Cay if the northwest edge of the green water of the Reef can be rounded during the daylight, instead of crossing at Jupiter and running down the latitude on the Florida coast. The current is weak on the Bahama side of the channel and on the edge of the Shoal there is practically none, but this route will be difficult at night time until a light is established on Mantanilla or one of the adjacent shoal spots near it. Another small light on Memory Rock would make the passage by this route to sailing vessels preferable to that by way of the Hole in the Wall.

Running down the Straits of Florida on the west side, the nearer to the coast and reefs the less the current until "The Elbow" is passed, after which it is not necessary to hold the Reefs so close aboard to avoid the Stream.

THE MAGNETIC QUALITIES OF GUN-STEEL.

By GEORGE O. SQUIER, Ph. D., First Lieutenant, Third Artillery, U. S. A.

[*Extract from a paper in the Journal of the United States Artillery.*]

In designing apparatus for some experiments which were to involve the use of the steel of our new heavy guns under the influence of magnetizing electric currents it became desirable, if not necessary, to know something of the qualities of this steel in a magnetic sense, in the actual final condition in which we find it in the finished gun. In obtaining data for the above purpose, the tests were made with considerable care, and some of the results are here recorded that they may be of use in case similar data are desired in the future, which seems not improbable in view of the rapid advance now being made in the utilization of electrical power for controlling heavy cannon. As has long been known the magnetic value of wrought iron is several times greater than that of cast iron, and the magnetic behavior of each of these as well as steel is so dependent upon its chemical constitution, physical properties, and treatment during manufacture, that tests of the magnetic qualities of iron for electrical machinery have risen to the importance of "tensile strengths" and "elastic limits" in civil engineering operations. Only recently Professor Ewing* has made a large number of tests of sample iron rings submitted by different manufacturers in England which will prove of great service to electrical engineers as well as to the manufacturers themselves.

The experiments described were carried out in the laboratory of the Johns Hopkins University, and were made upon a muzzle-ring from a 3.2-in. breech-loading rifle cut from the gun as the last operation, and therefore furnished a sample of the physical condition of a finished gun. The steel originally came from the Bethlehem Iron Company, of Bethlehem, Pennsylvania, and is a low steel of remarkable physical qualities, forged, oil tempered and annealed.

* *The London Electrician*, April, 1894.

RESULTS.

The tests indicate that the steel of our new guns, besides possessing remarkable physical qualities, also has excellent magnetic qualities and, but for the cost, could be used for the construction of electrical machinery with very efficient results. In fact a comparison of the curve with Hopkinson's curve for the best wrought iron shows them to be practically the same in character, and when further compared with the curves for the average steel *castings* from various manufacturers* in the United States, we find magnetic values about 8 per cent. in favor of gun-steel. This indicates an improvement produced by forging as compared with simple steel castings, and for marine dynamos, and in gun-training motors when space is valuable, steel of high permeability will, probably, be exclusively used in the future.

Passing to the hysteresis behavior, it is observed that the curve is of the characteristic "square-shouldered" type, which is often found in steel and almost always in annealed soft iron. The bend in the curve, which is not a decided "knee" in this case, divides the curve into parts corresponding to the stable and unstable conditions in Ewing's theory. The rate of descent from the bend during the reversal of the magnetism is remarkably rapid and uniform, while the comparatively small area inclosed shows the effect of annealing.

Hardening steel increases hysteresis loss so that samples with exactly the same chemical constitution show very different losses, depending upon whether they have been annealed or hardened.

The bend in the curve being very slightly on the negative side of the axis of B shows that when the force is zero the remaining magnetism is still in the saturation part of the curve and therefore in stable equilibrium, indicating that the remaining magnetism is rather persistent and comparatively difficult to destroy.

The hysteresis formula from these becomes

$$W = .078\left(\frac{B_1 - B_2}{2}\right)^{1.6} = \text{energy dissipated in ergs per cycle, and cm}^3 = 10^{-7}$$

watt-seconds.

This value of $\eta = .0078$, places gun-steel, as expected, between average wrought iron ($\eta = .003$) and average cast iron ($\eta = .013$) as given by Steinmetz's researches.

An accurate hysteresis constant is obtained only after the examination of many specimens of the metal and averaging many cycles, and the value given is submitted until it can be corrected by further tests.

From data which has but recently come to hand, it would appear that there is a connection between the magnetic qualities and the physical conditions of steel as indicated by a combination of high physical qualities; for instance, nickel-steel, possessing in an unusual degree a combination of high elastic limit and ductility, is also found to possess exceptionally high magnetic permeability.

Since chrome-steel and nickel-steel are just now attracting much attention as metals for the construction of *cannon*,† as well as for armor and projectiles, the above fact assumes a military as well as a commercial interest.

* Cornell Experiments.

† Captain Gaston Moch, "A General Review of Existing Artillery,"—Chicago International Congress paper.

THE ARMOR-PLATE QUESTION—1894.

By W. H. JAQUES, Ordnance Engineer.

[*Extract from the Engineering Magazine.*]

A careful inspection of the methods and alloys employed in the manufacture of armor in the different countries discovers results which are difficult to accept. Great Britain has decided that the additional cost of the employment of nickel is not justified by the results ; that its use causes characteristics which are injurious ; but she has made no comparative test of thick plain steel and nickel-steel, such as have specially proved in America the value of nickel in armor-steel. The inferior results that have been obtained in the United States when chrome- and nickel-chrome plates have been experimented with are also surprising. When we consider the very excellent results that Witkowitz and St. Chamond have obtained and the large quantity of excellent armor the latter has turned out where her nickel chrome, untreated, uncarbonized armor has equaled, and in some cases surpassed, Harveyized plates, it would seem to be to the want of experience in the composition or subsequent treatment that failures must be ascribed.

I have advocated nickel-chrome armor because of the possibility of securing a very satisfactory product without the risks that Harveyizing entails in all plates, particularly in the thicker ones.

The test of thin shield plates containing alloys of chrome, nickel, and manganese, carbonized and uncarbonized, have not been productive of important results. They will no doubt be continued by the makers as well as by the Army and Navy Department, since such experimentation can be carried on at a moderate cost. A very tenacious, resisting nickel-chrome plate ought to be obtained without much difficulty, but considering the comparative ease with which thin plates can be surface-hardened, the nickel-steel carbonized plate ought to be as good as any. We have had so many tests of thin plates that we can prepare curves of resistance for them that can be almost perfectly relied upon. Specified qualities in these thin plates ought to be as readily obtained as standard boilers or shafting.

In connection with thin plates mention must be made of the successful practice that is being obtained with our 12-inch rifled mortars. Uncarbonized alloyed metal will probably resist mortar fire as well if not better than any other type, as brittleness must be avoided as much as possible where low velocity large caliber projectiles form the attack. All of the plates thus far tried have cracked badly. Ships not especially built with armored deck protection, must regard effective mortar fire with grave apprehension. With mortar fire from above and submarine artillery from below the bravest commander will hesitate to attack a thus protected port.

Unlimited discussion continues as to the comparative value of forged and rolled thick armor. Although rolling is a type of forging, I make a distinction here because the products of the two methods have been so often compared and are productive of such different qualities. I am still of the opinion I have expressed for many years that the forged plates are more resisting and economical than the rolled ones and that the forging should be done with the hydraulic press. This view has now been practically endorsed by Bethlehem's substitution of a press for its hammer ; the Carnegie Company's purchase of a Whitworth press ; John Brown & Co.'s purchase of a Whitworth forging press, carrying as it does this method into the Holy See of rolling mills ; England's adoption of the same method and by the prominence Continental writers are giving to the value of the hydraulic press.

Much valuable experimentation has been done to determine the action of various characters and types of projectiles. This has led to a marked improvement in their production.

The study of the most suitable velocities for perforation, giving time for a point entrance to hard faced armor, has given data that is at least interesting if not useful enough to be accepted as final. These trials of types and calibers are of much value to the armor maker and artillerist as they assist the former to decide the character of his product and the latter the caliber of his gun, the weight of his projectile and the ballistics he must seek to obtain.

Although repeatedly suggested, very little has been done to obtain actual remaining velocities by the use of screens behind plates in testing armor and projectiles.

The results obtained in the United States can safely be taken as a standard of what protection can be obtained with various thicknesses of armor, because more serious and numerous tests have been made with each than is the custom in other countries, notably Great Britain.

The tests of the past year have enabled us to reach conclusions that will enable our Navy Department to contract for armor for its variety of purposes, that will insure our getting the best, and we have again proved to our legislators that all we need is adequate financial encouragement to enable us to lead in all branches of naval architecture and ordnance engineering.

THE EFFECT OF STRESS ON THE CORROSION OF METALS.

At a recent meeting of the Institution of Civil Engineers, Mr. Thomas Andrews presented a paper on the above interesting subject, detailing his methods and the results obtained.

Mr. Andrews arrived at the following conclusion: That wrought iron and various steels, when exposed singly and separately, and without liability to galvanic action other than local, to the action of sea water for long periods, showed a greater corrosion on the part of all the steels than in the wrought iron. The advantage in favor of wrought iron was, roughly, 25 per cent. and upwards, as compared with the steels. It was also noticed that corrosion increased in the steel as the percentage of combined carbon was greater.

He also found that galvanic action between wrought iron and steel induced a largely increased total corrosion in the several metals. In tidal streams he found that the upper and lower portions of a metal structure, though composed throughout of the same metal, were exposed to electrolytic disintegration from the galvanic action set up by solutions of different salinity on the metal, the difference being due to the gradual rise and inward flow of salt water and the outward flow of fresh water. The author had already shown, in a previous paper, that there are indications that magnetic influence tends to increase the corrosion in steel.

To this is now added the additional information that stress considerably effects the rate of corrosion; and, contrary to expectation, it is the "unstrained" metal that is most liable to corrosion. In a previous paper, on the influence of stress on railway axles, the author attempted to show that stress of any kind alters the physical properties of iron and steel. Stress increases the rigidity of both, renders the metal harder and greatly reduces its properties of elongation or ductility. The same demonstration would apply to the corrosion tests; the strained metals were rendered harder in nature, and hence were less liable to corrosion in this strained condition than in the normal softer condition. The experiments indicate, however, that an increased total corrosion, in excess of the normal corrosibility of the metal, occurs from the action of the local galvanic currents which are shown to be induced between "strained" and "unstrained" portions of even the same iron or steel forging, bar or plate. Hence, a strain occurring in a metallic structure tends, owing to the local galvanic action thus set up, to increase any corrosion forces which may deteriorate the metal of which it is composed.

MAGNETIC PROPERTIES OF ASBESTOS.

[*Scientific American.*]

Mr. A. C. Swinton says: "In some recent experiments Mr. J. C. M. Stanton and I found that, employing a very strong electro magnet, a piece of ordinary white asbestos millboard, about 4 x 3 x 1-16 inches in size, and weighing one-half ounce, was easily lifted through a vertical distance of one and one-half inches, and when in contact with the magnet pole the asbestos board would support four ounces in addition to its own weight. Lumps of hard asbesto s such as are used in gas fires, as also pieces of soft asbestos cotton packing, were also strongly attracted, and when some of the latter was placed on the magnet pole and the current turned on and off, the individual fibers could be seen in movement. Further, it is quite easy to permanently magnetize a piece of asbestos millboard, when it will behave exactly as a magnet both in attracting and repelling a compass needle. The principal constituents of asbestos are stated to be magnesia, silica and alumina, with some oxide of iron. No doubt it is to the presence of the last named substance that the magnetic qualities are due. White asbestos is, however, understood to contain but small traces of iron—much less than the colored varieties—and consequently the degree to which it is magnetic seems surprising. In any case it may be well to warn experimentalists that asbestos is not a suitable substance to employ in connection with delicate instruments where any unsuspected permanent magnetism might be productive of serious error."

THE PNEUMATIC DYNAMITE GUN ON THE BRAZILIAN CRUISER NICTHEROY.

By EDWARD BRINLEY, Tenente Honorario d'Armada Brazileira.

[*Engineering News.*]

The projectiles furnished for this gun were of three sizes, viz.: 15-in. full caliber, 10-in. sub-caliber and 8-in. sub-caliber. The first carries a bursting charge of approximately 500 lbs., the total weight of the loaded projectile being 1000 lbs.; the second a bursting charge of 200 lbs., the total weight being 500 lbs.; the third, a bursting charge of 100 lbs., the total weight being about 300 lbs. They are made in sections, which are fastened together by countersunk screws passing through shoulders at the ends. Partitions are placed in the middle of certain sections to limit the weight thrown to the rear when the gun is fired and to expedite loading.

The 15-in. projectile carries a gas check near the rear end, held in place by a composition metal ring. The radial grating vanes are placed at the end of a heavy iron tube extending from the rear end of the projectile. In the sub-caliber projectiles sabots of wood are placed at the forward and rear ends. The forward sabot is in four pieces, each held in position while in the gun chamber by a composition metal stud, which fits in a socket in a composition metal ring, countersunk in the shell about an inch to the rear of the junction with the head. The force of the air against their forward faces detaches them from the projectile after it leaves the gun. The after sabot is secured to a composition metal ring on the after end of the projectile by metallic elbows. The force of the air breaks these elbows from the ring and the sabot drops from the projectile. Screwed into the rear of the sabot is a piece of iron pipe to keep the rear face of the sabot beyond the air ports. The gas check is on the periphery of this sabot. These gas checks are of leather. The radial

gyratory vanes on the sub-caliber projectiles are just forward of the band to which the after sabot is secured.

The fuses used were of the Rapieff pattern, and were constructed to explode either by a head on or glancing contact with water, the moment of explosion being retarded a short interval of time after the impact of the shell by the use of compressed black powder time trains inside the mechanical fuse. In the case of contact with a solid object, the explosion of the shell is instantaneous.

Off the island of St. Thomas, W. I., on Dec. 1, 1893, this gun was tested. A 10-in. projectile was used. Sail Rock Island was the target. The shell fell beyond the island. The cut-off valve was set for 1800 yds. No noise of an explosion was heard, and the general opinion aboard the ship was that the fuse did not operate properly and produce a detonation of the dry gun-cotton. The air pressure registered by the manometer at the gun was 1000 lbs., and all parts worked smoothly.

On May 3, 1894, this gun was again tested off the island of Santa Catharina. A point on Gale Island was the target. Two shells were fired. The first an 8-in. sub-caliber, at a range of 4300 yds., and the second, which was a 10-in. sub-caliber, at a range of 3700 yds. Both fell within a short distance of the mark. The explosion of each was terrific. I made a change in the fuses used in these projectiles, which, I believe, was the cause of the proper action taking place.

After this experience I felt satisfied that the shell fired at St. Thomas did not explode, and, further, I think that, as delivered by the manufacturing company, the fuses will not cause an explosion. This was the case with the test at Port Royal, S. C., of the gun on the U. S. S. Vesuvius.

There is a great deal of mechanism about this gun, which requires constant care and attention, and in climates where sweating of the metal is liable to take place, the working parts would have to be removed and examined very frequently. As some of the parts are quite heavy this takes much time. In order to ascertain if all the packings are tight, air pressure must be put on the gun. Again, although every part may be found in good order when tested, at the critical moment one of the packings may develop a leak.

The range of this gun is not sufficient to prevent ships with heavy guns doing all the damage they may desire. A gun of this type, unless placed on a heavy armored vessel and entirely protected, would be liable to be rendered useless by the heavier rapid-fire guns before any use could be made of it. If a slow burning powder were made which could be used in firing shells charged with gun-cotton from long guns, the range could be increased and the gun much simplified.

THE USE OF CAPTIVE BALLOONS AT SEA.

Colonel Nicolas d'Orloff communicates to the *France Aerienne* some interesting details of the seach made from a captive balloon to try and discover the whereabouts of the ill-fated Russian war-ship Rusalka. The search party, which consisted of one officer, an engineer, and twenty-five soldiers belonging to the aerostatic park of St. Petersburg, arrived at Helsingfors on June 16 in the transport Samoyede, which was specially fitted up to facilitate the ascents of the balloon. From June 23 to July 12 the Samoyede was towed out daily at 6 A. M., and returned every night to Helsingfors. The balloon employed had a capacity of 640 cubic metres, and ascended to altitudes varying between 200 and 440 metres (656 to 1443 feet); with a head wind it was towed at a rate of 2¼ knots, but when the wind was favorable the speed was sometimes as much as 6¾ knots. Two observers, who were relieved every three hours, were constantly in the car, and it was found that the naked eye

was better adapted to discern objects at the bottom of the sea than if glasses were used. According to Colonel d'Orloff, the following are some of the chief conclusions arrived at: 1. With the balloon at a height of 400 metres it is not possible to see to the bottom of the sea at a great depth in consequence of the impediment to vision offered by the color of the water and of the bottom. 2. With a favorable light rocks and sandbanks were clearly defined at depths of from 6 to 7 metres (19 to 23 feet). 3. Large sandbanks could be seen more or less distinctly according to the color of the water at a depth of 40 feet, but at this depth it was impossible to distinguish in detail objects lying at the bottom. 4. With the inflated balloon hauled down on deck and screened by a sail the towing-boat could steam at a speed of 8 knots with a head or side wind blowing with a velocity of 26½ feet a second. 5. The view from the car extended to a distance of 75 kilometres (46½ miles). When the balloon was sent up at Helsingfors it was possible to see Reval and to hear guns, and to see their smoke, fired near Reval when nothing could be seen or heard on terra firma. 6. Observations from a captive balloon are more easily carried out at sea than on land, because the air currents are more uniform and are not so subject to sudden change. Objects can be seen better on the surface of the water than on land. Any vessels sighted can be distinguished perfectly and there is no difficulty in recognizing whether they are merchantmen, men-of-war, or pleasure boats. From the experience gained on this occasion Colonel d'Orloff concludes (*a*) that captive balloons would be of great utility as observatories to a fleet; (*b*) that observations made at sea with captive balloons would also be of the greatest assistance in reconnoitring the entrance of unknown harbors, in hydrographical researches, and also in reconnoitring the enemy's ships and ports, more especially as by their means the exact position of forts, batteries, and the various coast defences could readily be ascertained.

THE SUBMARINE DETECTOR.

[*Scientific American.*]

It is now a little over a year since the Russian monitor Rusalka foundered with all hands in a storm in the Gulf of Finland. To discover the precise locality of the vessel, with the view of raising her, an expedition set out with divers and all necessary apparatus, including one of Captain McEvoy's submarine detectors, which was made in London for the expedition. It has recently been ascertained that the spot where the Rusalka went down is a reef near the Waster Tokan, a rocky islet southwest of Mjolo, and one of the outermost rocks off the Finland coast. The reef is submerged, and it is supposed that the Rusalka grounded there, and subsequently slipped off into the surrounding deep water. Her precise position has been localized in 30 fathoms of water by means of the detector. This apparatus consists simply of an electrical arrangement contained in a small mahogany box, which is carried on board the searching vessel, and a sinker, which is trailed along the bottom. The sinker also contains an electrical arrangement, and is connected with that in the box by a light electrical cable of any required length. When the sinker approaches a mass of steel, iron, or other metal, sounds become audible in a telephone on board, while they are reduced in intensity as the sinker recedes from the metallic object. Three hundred feet of electrical cable were employed in this search, which was continued for several weeks. The exact position of the foundered vessel was at length placed beyond all question, as every time the searching steamer passed over a given spot the electric indicator of the detector sounded loudly, thus affording evidence that a large mass of metal was submerged below. The divers then descended and

examined the ship. She had foundered through serious damage to her stern. The examination was only external, the hatches being so firmly fixed that they could not be opened.

Although most appropriate for the purpose of searching for wrecks of iron ships, the submarine detector was primarily designed by Captain McEvoy to indicate the approach of iron ships to anchored torpedoes, as well as to search for stray torpedoes, lost anchors and chains, telegraph cables, and the like. The approach of a mass of metal, such as an enemy's iron-clad, to a torpedo disturbs the balance and causes the sounds to become audible in the telephone. The torpedo may then be fired electrically by means of the cable connection, the invention thus presenting itself as an important adjunct of coast defense.

THE DECENNIAL PROGRAMME FOR NAVAL CONSTRUCTION IN FRANCE.

[*The Engineer.*]

As soon as the Naval Defense Act of Great Britain was passed in 1889, France, realizing her inferiority as a maritime power, and the difficult position that she must occupy in the future unless she raised herself to the level of the efforts which were being made in other countries, determined also to have a distinct programme issued for new naval construction. With this object in view a campaign was actively opened in maritime centers, in Parliament, and amongst the people themselves. But it was not until the end of 1891 that the Admiralty Board of France set forth the programme that we give below in tabulated form, which was to last a period of ten years:

Sea-going battleships					10
Coast defense iron-clads					1
Cruisers	1st class	Sheathed	8	9	45
		Unsheathed	1		
	2d class	Sheathed	12	19	
		Unsheathed	7		
	3d class	Sheathed	12	17	
		Unsheathed	5		
Torpedo depot ships					4
Floating workshops					2
Torpedo gunboats					5
Torpedo-boats, first-class					8
Gunboats					7
Total					82 vessels.

Thus the decennial programme passed by the Admiralty Board provided that within ten years after the commencement of the year 1892, the naval arsenals and the trade should build the eighty-two vessels of which we have just given the detail; the work then was to be completed at the expiration of 1901.

The total cost for thirteen representative vessels out of each of the thirteen classes enumerated may be estimated at £4,768,000, giving an average of £366,769 for each ship. This average, multiplied by eighty-two, gives a total of thirty millions sterling in round numbers, or in other words, the Admiralty Board decided upon a naval budget, as regarded new shipbuilding, amounting to thirty millions sterling extending over a period of ten years. From 1889 to the end of 1899, that is to say, for an equivalent period, England will have reached a figure representing nearly the double of this.

Once the decennial programme of 1891 was voted in Parliament, the Admiralty Board deemed it necessary to begin in good time the eighty-two ships, in order that they might be completed at the end of the year 1901. Now, for the first three years—1892, 1893 and 1894—the numbers laid down should have amounted to 29, viz: sea-going battleships, 6; first-class cruisers, sheathed, 2; unsheathed, 1; second-class cruisers, sheathed, 2; unsheathed, 4; third-class cruisers, sheathed, 4; unsheathed, 3; torpedo-depot ships, 2; floating workshops, 1; torpedo-gunboat, 1; gunboats, 3. Total, 29.

Has this programme been carried out? This is the point to be determined. We will see first what provision was made for each of the years alluded to, then we will ascertain how these anticipations have been verified. Lastly, we will make a total of all the new ships which have been laid down during these three years, a total that we will compare with the total as above, anticipated by the Admiralty Board. We shall not be long in seeing that the decennial programme has been more and more departed from; indeed, that it is on the point of being completely abandoned. The provision for 1895 will afford us proof of this fact.

What were the ships to be laid down in 1892? The Bouvet and Masséna, battleships; the Pothuau, first-class cruiser, unsheathed; the Descartes and Pascal, second-class cruisers, sheathed; the Linois, third-class cruiser, sheathed; the Foudre, torpedo-depot; the Cassini, torpedo gunboat. Upon this estimate six vessels only out of eight were laid down, two were set aside, a cruiser of the first-class, sheathed, the Pothuau, and a second-class cruiser, sheathed, the Pascal. Already, so early as the first year, 1892, the programme anticipated failed in its execution; we shall see later on that this process will be accentuated more and more.

Before passing on to the estimates for 1893, we think that it may be interesting to give the principal characteristics of these ships, which are not yet in the service.

The Bouvet, battleship, was laid down at Lorient. She will have three screws, worked by three independent sets of vertical engines. Total horse-power, 14,000; speed, 17 knots with natural and 17.5 with forced draught. Dimensions: Length, 382 ft. 3 in.; beam, 70 ft. 3 in.; draught, 27 ft. 7 in.; displacement, 12,205 tons. For protection, an armored belt 8 in. to 16 in. thick, and an armored deck of 3½ in. maximum thickness. Armament: two guns, 11¾-in. caliber, forward, and two 10½-in. caliber, aft, in closed turrets; eight quick-firing 4-in. guns, with shields upon the superstructure; twelve guns of 47 mm., and twenty of 37 mm.; five torpedo-tubes. Cost about £1,080,000.

The Masséna, battleship, building at St. Nazaire, Les Ateliers et Chantiers de la Loire. Dimensions: Length, 368 ft. 6 in.; beam, 66 ft. 6 in.; draught, 26 ft. 3 in.; displacement, 11,730 tons. Speed, 17 knots with natural, and 17.5 with forced draught. Three independent sets of engines developing a total of 12,600 horse-power and triple screws. Protection will be distributed as follows: At the water-line a steel belt from 10 in. to 17¾ in. thick; upon the turning portions of the great turrets, 13¾ in., and upon the fixed parts 15¾ in. of steel; upon the small turrets, 4 in. to 5½ in.; shields of steel for the minor artillery. The armored deck 3½ in. The armament will consist of two guns, 11¾-in. caliber, in revolving turrets, one forward, the other aft; two guns of 10½-in. caliber in turrets on the broadsides; eight quick-firing guns of 5½-in. caliber, also in turrets; eight quick firing guns of 4-in. caliber upon the superstructure, with hardened steel shields; thirty-two smaller quick-firers or machine guns of 47 mm. and 37 mm., and five torpedo-tubes. There will be twenty-four boilers upon the Lagrafel and d'Allest system. Cost about £1,080,000.

The Descartes, second-class cruiser, sheathed, building also at St. Nazaire. Length, 315 ft. 6 in.; beam, 42 ft. 4 in.; depth, 30 ft. 7 in.; draught, 19 ft. 9 in.; displacement, 3888 tons; horse-power, 9000; speed, 18 and 19 knots.

A protective deck sloped at edges. Armament: Four 6¼-in. quick-firing guns in sponson ports on the bows and quarters; ten 4-in. quick-firing guns, four pointing ahead and astern, six raised upon the shelter deck and forecastle; fourteen of 47 mm.; eight of 37 mm., and two torpedo-tubes ahead. Cost a little more than £320,000.

The Linois, third-class cruiser, building at La Seyne, Forges et Chantiers de la Méditerranée. Length, 321 ft. 6 in.; beam, 34 ft. 6 in.; draught, 17 ft. 5 in.; depth, 22 ft. 5 in.; displacement, 2270 tons; horse-power, 6600; speed, 19 and 20 knots, with natural and forced draught respectively. A protective armored deck of 1½ in. in thickness. Armament: two quick-firing guns, 4-in. caliber, forward and aft; four quick-firing guns, 4 in. caliber, sponsoned out on the broadside; eight quick-firing guns of 47 mm.; four quick-firing guns of 37 mm.; four revolving guns of 37 mm., and four torpedo-tubes, two ahead, two pointing laterally. An armored hardened steel conning tower 4 in. thick for the captain. Cost about £200,000.

The Foudre, torpedo depot ship, building at Bordeaux, Chantiers de la Gironde. Torpedo depot ships are intended to accompany squadrons of armored vessels, and to place at the disposal of admirals a certain number of torpedo-boats, which will arrive in good condition, because they will not have made the passage by their own efforts. But this type is a subject of sharp controversy amongst French sailors; some deem that it is useless, each battleship being able to carry similar torpedo-boats to those which are found upon the Foudre. Others believe that this class of ship is destined to render great service, being a valuable attribute to a squadron, as a sailing torpedo-depot and workshop. The Foudre has a length of 370 ft. 6 in.; beam, 51 ft. 3 in.; draught, 20 ft. 2 in.; displacement, 5970 tons; horse-power, 11,000; speed, ordinary draught, 18.5 knots; forced, 19 knots. An armored protective deck, 2 in. thick in the center, 4 in. thick on the sides. The armament comprises eight guns, quick-firing, of 4 in. caliber; four of 65 mm.; four of 47 mm., and five torpedo-tubes. This cruiser will carry upon the deck eight 14-ton torpedo-boats, of a speed of 16.5 knots, that she can embark and disembark by means of derricks. Moreover, she will have special machinery that will enable her during the course of a campaign to repair torpedoes and their gear. The Foudre is a natural sequence of the Hecla and Vulcan, British torpedo-vessels. The cost will be £400,000.

The Cassini, torpedo-gunboat, building at Graville, near Havre, by the Forges et Chantiers de la Méditerranée. Length, 262 ft. 6 in.; beam, 27 ft. 4 in.; draught, 11 ft. 6 in.; depth, 17 ft. 4 in.; displacement, 943 tons; horse-power, 5000; maximum speed, 21 knots. The motive power will consist of two sets of verticle triple-expansion engines, making 266 revolutions per minute. The armament will comprise one quick-firing 4-in. gun; three of 65 mm. and four of 37 mm., with three torpedo-tubes. Cost nearly £120.000.

Let us pass now to the year 1893, and see what was to be laid down for that year. The d'Entrecasteaux and Jeanne d'Arc, first-class cruisers, sheathed; the Pascal, second class cruiser, sheathed; the Duchayla, d'Assas, and Catinat, second class cruisers, unsheathed; the Galilée, third-class cruiser, unsheathed; Casabianca, torpedo-gunboat; Surprise, gunboat. Out of this estimate of nine vessels, seven only were laid down; two were set aside, the Jeanne d'Arc and the Catinat. On the other hand, the Pothuau was, in addition to the estimate, reinstated from the estimate for 1892 and laid down, making eight in all. Let us look at the characteristics of these eight vessels laid down in 1893.

The d'Entrecasteaux, sheathed cruiser of the first class, intended for distant stations, building at La Seyne. Length, 384 ft.; beam, 58½ ft.; draught, 23 ft. 6 in.; water-line area, loaded, 1534 square meters; displacement, 8144 tons; horse-power, 14,000; estimated speed, 19 knots, with moderate forced draught, and burning 130 kilos. of fuel for each square meter of grate surface. The steam will be supplied by five cylindrical boilers of return draught

pattern, placed four in front of the engines, and the fifth behind between the screw shafts, a disposition which will admit of bringing the engines near the center of the ship, and of giving them more room. The boilers will be tested to 10 kilos. Protection will be afforded by an armored deck with sloping edges 4 in. thick, plating included at the sides, and by another horizontal deck $\frac{7}{8}$ in. thick above; the space between these two decks will form an immense cellular caisson, which will contain reserve fuel and stores. The hull will be entirely devoted to the engines, the boilers and the magazines, which will be very numerous, each gun having its own separate ammunition trunk. All the auxiliary apparatus, steering engines, electric engines for lighting and for the distribution of power to the helm, and for the working of the guns, such as the ammunition hoists, turret gear, etc., will be under the shelter of the armored deck. All will be actuated by electricity. The armament will include two 9½-in. guns of 40 calibers, in closed balanced turrets fore and aft, protected by 10 in. of steel and trained by electricity. Twelve quick-firing 5½-in. guns will be distributed as follows: Four upon the spar deck, bearing ahead and astern, placed in the center of the ship, and protected by 2¾-in. shields of hardened steel and by the bulwarks: eight in a redoubt upon the upper battery, protected as the others, and all firing axially, thanks to their disposal *en échelon*. Each of the 5½-in. guns will have its magazine and its rack for projectiles. Twelve quick-firing guns of 47 mm. and four of 37 mm., will be distributed upon the superstructure and in the tops; these will have regular platforms. Two torpedo-tubes below and five above the water-line. There will be two military masts with interior staircases. The d'Entrecasteaux will be very solidly constructed. The weight of the hull amounts to 2989 tons, that is to say, 36 per cent. of the displacement; the armor will weigh 1670 tons, the armament 482 tons, the motive apparatus 1395 tons, and at normal draught the ship will carry 650 tons of coal; but with the reserve supply this quantity will increase to about 1000 tons, which will give a good radius of action. The d'Entrecasteaux will be the largest of the French cruisers. Like all modern vessels she will be complicated. However, it may be said that the autonomy of, and the protection afforded to each of the guns will be complete, and that great care has been taken to localize possible damages caused by the fire of the enemy. Besides the armored conning tower, several protected positions have been arranged for the captain. The ship will cost about £680,000.

The Pothuau, first-class cruiser, building at Havre by the Forges et Chantiers de la Mèditerranèe, is a Latouche-Trèville, enlarged and more powerfully armed. She will cost a little more than £440,000.

The Pascal, second-class cruiser, sheathed, building in the arsenal at Toulon, similar to the Descartes, described above. Cost about £320,000.

The d'Assas, second-class cruiser, building at St. Nazaire. Length, 325½ ft.; beam, 44 ft. 11 in.; draught, 19 ft.; depth, 29 ft. 9 in.; displacement, 3952 tons. Protective deck on the flat, 1½ in.; on the sloping sides, 3½ in. Two vertical triple-expansion engines, developing a normal horse-power of 6000; maximum horse power, 9500. Steam supplied by twenty d'Allest boilers, tested to 20 kilogrammes to the centimeter; speed, 19 knots. Armament: Six 6½-in. quick-firing guns, four 4 in., twelve of 47 mm., sixteen revolving guns of 37 mm., and six torpedo tubes. Cost, £300,000.

The Duchayla, second-class cruiser, building at Cherbourg. Similar to d'Assas, just described.

The Galilée, third-class cruiser, building at the arsenal, Rochefort. Length, 321½ ft.; beam, 35 ft. 1 in.; draught, 14 ft. 7 in.; depth, 23 ft. 2 in.; displacement, 2317 tons; horse-power, 6500; speed, 19 and 20 knots with natural and forced draught respectively. A protective armored deck with sloping edges. Armament similar to that of the Linois, already described; a conning-tower for the captain, 4 in. thick, of hardened steel. Cost, £200,000.

The Casabianca, torpedo gunboat, building at Bordeaux, Chantiers de la

Gironde. Length, 262 ft. 6 in.; beam, 27 ft. 4 in.; draught, 10 ft. 3 in.; displacement, 943 tons. The strength of the hull is reinforced, and it is of hardened steel in the vicinity of the engines and boilers. Two vertical four-cylinder engines will give her a speed of 21½ knots, with the maximum power of 5000 horses. The boilers, upon the d'Allest system, will be tested to 15 kilos. to the centimeter. They will be arranged in four groups, each with two furnaces. Armament: One quick-firing gun of 4-in. caliber, three of 65 mm., five of 47 mm., four of 37 mm. Cost, £100,000. She is a sister-ship to the Cassini.

The Surprise, gunboat, designed by M. Normand, who is building her at Havre. Length, 183 ft. 9 in.; beam, 24 ft. 7 in.; draught, mean, 10 ft. 2 in.; depth, 14 ft.; displacement, 626 tons. The Surprise will be of steel, sheathed, and will have one propeller. A vertical engine and four cylinders will develop 650 and 850 horse-power with natural and forced draught respectively; maximum speed, 13 knots. Boilers tested to 11.25 kilos. to the centimeter. Armament: Two quick-firing guns of 4-in. caliber, four of 65 mm., four of 47 mm. This gunboat will have three masts—two masts barque-rigged, the foremast square-rigged. The total sail surface will be 344.93 square meters. Cost, £48,000.

Let us now pass along to 1894, and see what ships were estimated to be laid down this year:—The Henry IV., Charlemagne, and Saint Louis, battleships; E^3, E^5, E^6, second-class sheathed cruisers; G^2 and Cassard, second-class unsheathed cruisers; Lavoisier, third-class unsheathed cruiser.

Out of these nine estimated units, *four only* have been laid down—the Charlemagne, the Saint Louis, the Cassard, and the Lavoisier. All the other units have been relegated to 1898, or even to a more distant date; but it is only fair to say that two units not estimated for in 1894 have been laid down this year—the Jeanne d'Arc and Catinat, reinstated from 1893. It is thus shown that, in 1894, six ships will be laid down instead of nine.

The Charlemagne, battleship, building at Brest Arsenal. Length, 385 ft.; beam, 66 ft. 7 in.; draught, 25 ft. 10 in.; displacement, 11,232 tons. The height of the freeboard guarantees her being a good seaboat. The subdivision of the hull has been specially studied, with a view of reducing as much as possible the danger caused by the inrush of water upon the main deck and into the compartments alongside. In order to minimize the effects of a blow from a ram, or of the explosion of a torpedo, the designer has multiplied the compartments of the hull, especially alongside. With a view of increasing the protection against projectiles striking the armor on the main deck, he has adopted two armored decks—one, 2½ in. thick, situated, as in all other ironclads, at the level of the upper edge of the armored belt; the other, 1½ in. thick, situated at the level of the lower edge. Below this second deck will be placed all the vitals of the ship, engines, boilers, apparatus for training the turrets, magazines, etc. The space between the two decks is, properly speaking, an enormous cofferdam. It is extensively subdivided, so as to stop the inrush of water. The armored belt which surrounds the ship is 6 ft. 6¾ in. in width; its upper edge rises to 19½ in. above the water-line. In the middle of the ship the thickness of this belt is 15¾ in., over a depth of 2 ft. 3½ in. measuring from the upper edge. The belt decreases from this downwards to the lower edge, where it is only 10 in. thick. Armor 3 in. thick, which goes completely round the ship, secures the foot of the upper works from the destructive effect of lighter ordnance. Behind the light armor runs along a cofferdam, one meter in height, which rests upon the main deck, and goes round the ship. The divisions, in sheet steel, of this feature complete the subdivision of the space situated above the main deck. The getting rid of the water which reaches the main deck, by possible damages of the outer skin, is effected by means of large pipes, which expel the water at once, without the necessity of discharging it at first into the hold, or into a drain. A battery, composed of eight quick-firing guns of 5½-in. caliber, is placed under the shelter deck, which extends to the forcastle. It is protected by exterior steel

armor, 3 in. thick, including the plating, and by a traverse similarly armored forward, which descends to the main deck. In order to provide that a projectile bursting in the battery shall not disable all the guns at once, each of them is enclosed in a drum of plate steel, which isolates it from its neighbors. The superstructure is less developed than upon the earlier ironclads. The conning tower, placed before the foremast, is armored with 4 in. steel. Beside this conning tower there are two other armored cylinders from which the captain can transmit his orders to the engines and to the helm. These three protected posts are connected with another post situated upon the lower deck, at the foot of the armored trunk which connects the principal conning tower with the interior of the ship, and thence orders can radiate to the boiler-rooms, engine-rooms, turrets, etc. The military masts have double staircases inside; besides two tops at their highest part, they carry a shield at a certain height above the bridge. Anchors will be supplied upon the Manel system.

The motive power will embrace three triple-expansion engines, with four cylinders to each, of which two can be detached. Each of these engines will work a screw. One of the screw-shaft beds will be placed in the longitudinal axis of the ship, the two others will be alongside, and the screws will be distributed over a frontage of very considerable extent. Each engine will be placed in a water-tight compartment. They will communicate with one another, and with the boiler-room compartments, by means of water-tight doors situated upon the upper floors. Twenty boilers upon the Belleville system will supply steam. The engines are calculated to develop 14,000 horse-power with forced draught. Estimated maximum speed, 18 knots; with natural draught the speed should be 17 knots. The supply of coal, sufficing to steam 4000 knots at a speed of 10 knots, will be about 600 tons; but the bunkers are calculated to receive a much more considerable quantity—about 1100 tons.

The armament will comprise four guns of 11¾-in. caliber, of the 1891 model, mounted in pairs in two closed turrets placed at the ends of the ship; ten 5½-in. quick-firing guns, eight in the battery before alluded to, two upon the shelter deck; six 4-in. quick-firing guns upon the shelter deck; sixteen of 47 mm.; eighteen of 37 mm.; four submarine torpedo tubes, two ahead on the bows and two astern, bearing on the quarters; and six torpedo tubes above the water-line. The forward turret has a command of 27 ft. 10 in. and the aft turret a command of 21 ft. 4 in. We have already indicated the means adopted for protecting the guns mounted in the secondary battery. Upon the shelter deck, the 5½ in. guns will have a revolving shield, but those of 4 in. caliber will be without any protection. The disposition of the ammunition magazines will be especially convenient. All the magazines will be found directly beneath the guns which they supply. Speaking generally, all applications of power will be effected by means of apparatus moved by steam, hydraulic force, or electricity. The ship will be completely lighted by electricity, and will have six projectors.

The Saint Louis, battleship, building at the Arsenal at Lorient, will have similar characteristics to those which we have noted in the Charlemagne. Each of them will cost about £1,080,000.

The Jeanne d'Arc, first-class cruiser, sheathed, estimated to be laid down in the year 1893, was provisionally laid aside. The anticipated expenditure on her for 1894 will be £6440.

The Catinat, second-class cruiser, will be sheathed with wood and coppered which shows that she is intended for distant stations. Building at Graville, near Havre, by the Forges et Chantiers de la Mèditerranèe. Length, 328 ft. 9 in.; beam, 41 ft. 4 in.; draught, 19 ft. 8 in.; depth, 30 ft. 6 in.; displacement, 3998 tons. Protection, an armored deck of 1⅛ in. on the flat, of 1⅝ in. upon the glacis. This deck will be laid upon plating ⅜ in. thick. A cellular band will run along above the armored deck, over which will be a splinter deck. Horse-power of engines, 7000 with natural draught, 9000 with forced. Maximum speed, 19 knots. The boilers will be upon the Belleville system, Arma-

ment, four 6¼-in. quick-firing guns; ten 4-in.; fourteen 47-mm.; four 37-mm., and six torpedo tubes of 13¾-in. caliber. The 6¼-in. guns will be in sponsons upon the deck; four 4-in. guns will be under the forecastle, and two upon it; four distributed upon and under the poop. A portion of the 47-mm. guns will be in the lower tops, and 37-mm. guns in the upper tops. She will have six electric projectors, two military masts, and two tops on each. The conning tower for the captain will be of 4-in. steel armor. The cost will be a little over £320,000. The Cassard, second-class cruiser, unsheathed, building at Cherburg Arsenal, will be similar to the Duchayla and the d'Assas, which we have already described. The Lavoisier, third-class cruiser, not sheathed, building at Rochfort, similar to the Galilée.

We have seen at the outset of this brief survey, that the number of ships laid down in 1892, 1893, and 1894, should amount to 29 units; in reality they only compute to 20, of which the following is the detail:—

			1892.	1893.	1894.	Total.
Battleships			2	—	2	4
Cruisers,	1st class	sheathed	—	1	1	2
		unsheathed	—	1	—	1
	2d class	sheathed	1	1	1	3
		unsheathed	—	2	1	3
	3d class,	unsheathed	1	1	1	3
Topedo depot ship			1	—	—	1
Torpedo gunboats			1	1	—	2
Gunboats			—	1	—	1
Total			6	8	6	20

There will only have been laid down, therefore, during the three years four battleships instead of six; three second-class cruisers, unsheathed, instead of four; one torpedo depot ship instead of two, and one gunboat instead of three. The programme for first class cruisers will, however, have been accomplished, and it will be exceeded by one second-class cruiser, sheathed, and one torpedo-gunboat. But nothing will have been done for the four sheathed third-class cruisers, or for the two floating workshops.

To sum up, we repeat that instead of twenty-nine units, we shall only find at the expiration of the year 1894 twenty units upon the stocks—nine will be wanting at the roll-call. For 1895, the scheme presented to the Chamber of Deputies has only anticipated the laying down of two ships—a battleship, A^7, and a second-class cruiser, E^4. As for the Henry IV., the sheathed second-class cruisers E^5, E^6, and a second-class cruiser, unsheathed, C^3, they are relegated to a date more or less distant.

We were right, then, in saying, at the commencement of this paper, that the decennial programme for naval construction in France had not been verified. This is what we wished to prove.

THE RUSSIAN NAVY.

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Translated by LIEUTENANT HUGO OSTERHAUS, U. S. Navy.

The Russian navy has recently attracted the attention of the English press and naval men. In view of a Franco-Russian alliance, England's principal and natural opponent, her building programme of the future depends on the effective strength of the combined fleets of these countries. Information in regard to the Russian Navy is more meagre and less reliable than that of any of the

other great naval powers. The opinion of a French naval officer and known naval writer contained in a long article on the Russian navy in "La Vie Contemporaine," are therefore of special interest.

In consequence of her extensive coast line, and of her widely separated maritime frontiers, Russia is compelled to maintain four fleets, each with its own particular personnel and material, viz: the Baltic, the Black Sea, the Caspian, and the Siberian fleets. In the following only such vessels as would be serviceable, and would play an active part in case of war, are considered; and those numerous ships and craft which are maintained by the Russian Admiralty for special service in peace, and which in war would remain in protected harbors, are disregarded.

1. *The Baltic Fleet.*—Six sea-going battleships, one, the double turret ship Peter Velikie, was built in 1872, and has a speed of 14 knots; the other five, however, are of more recent date (1887–1892), have a speed of 16 knots, are heavily armored and carry heavy armaments.

Nine armored cruisers. One of these, launched in 1867 should hardly be considered among these, as neither her construction nor her speed come up to modern requirements. Of the remaining eight, five have only a moderate speed, so that only three, the Rurik, the Admiral Nakhimoff and the Punjab Azova, possess all the requirements of modern war vessels.

Twenty armored coast defense ships. All these vessels are old, having been built between 1863 and 1868; their speed is low, and their armor protection is weak.

Two protected cruisers. These ships have a protective deck over the vital parts. One of these cruisers, the Rynda has a speed of only 15 knots, while the other, the Admiral Korniloff, has a speed of 18.5 knots, which makes her a serviceable war cruiser.

Three armored gunboats. These are new, steam 15 knots and are heavily armed.

Three torpedo-cruisers. Their speed ranges from 20 to 22 knots; they have been recently built.

Twenty-seven high-sea torpedo boats. Their speed ranges from 19 to 25 knots, and nearly all are excellent vessels. Ninety-one first and second-class torpedo boats for coast defense.

2. *The Black Sea Fleet.*—Five sea-going battleships, all modern; the oldest was launched in 1886. These vessels are of a very formidable type, are heavily armored, and carry particularly powerful armaments; all have a speed of from 16 to 17 knots.

Two armored coast defense vessels; these are the noted nearly circular vessels, known as Popaffkas.

Two torpedo-cruisers, very modern vessels; one has a speed of 18.5 knots, the other, of 21 knots.

Sixteen high sea torpedo-boats, whose speed varies from 18 to 22 knots. The latest one, the Adlu, built by Schichau, at Elbing, has attained a speed of 27.5 knots, and is the fastest boat in the world.

Two torpedo-transports of moderate speed, and seven first-class torpedo-boats for coast defense.

3. *The Siberian and Caspian Sea fleets.*—In Siberia, Russia has a small squadron of four gunboats, and six coast defense torpedo-boats.

On the Caspian Sea, she has two gunboats and several small steamers for patrol and police duties.

To these ships, which are ready for service, or nearly so, must be added those now in course of construction, and which will sooner or later augment the effective strength of the Russian Navy.

There are in course of construction at the different ship-yards on the Neva four armored ships of the first class, two armored coast defense vessels, five sea-going torpedo-boats, and two armored cruisers of an improved Rurik type. The keels of an armored ship of the first class, eight sea-going torpedo-boats, and two torpedo-cruisers will shortly be laid.

At the ship-yards on the Black Sea, a battleship of the first class, the Drei Heilingen, has been launched, and the keels of two others will be laid as soon as possible, while a torpedo-cruiser is approaching her completion. All battleships are heavily armored, carry powerful armaments, and have a speed of 17.5 knots.

The above organization may be called the geographical grouping of the Russian Navy. It will be of interest to arrange the several elements tactically so that at a glance it can be seen what the effective strength of Russia will be in the event of a naval war, and in such manner that after the ships composing the offensive fleet, have been grouped together, the strength of the second line for the defense of the coast will be shown.

In the Baltic, the offensive fleet would be composed of five battleships, three armored cruisers, two protected cruisers, three torpedo cruisers, and twenty-seven sea-going torpedo-boats; and in the Black Sea, five battleships, six first-class gun-boats, two torpedo cruisers, and sixteen sea-going torpedo-boats.

The coast defense fleet in the Baltic would consist of one battleship, twenty armored coast-defense vessels, six armored cruisers, eleven cruisers, second class, and ninety coast defense torpedo-boats, and in the Black Sea, two coast defense battleships and seven coast defense torpedo-boats.

Of the Black Sea fleet it is hardly necessary to speak, as its radius of action is at present limited to that body of water. In case it should be desired to send it to the Mediterranean, a passage through the Bosphorus and Dardanelles would have to be forced as the Turkish fleet would refuse the right to pass. In case of war these straits could only be passed by force, and Russia would find herself constantly confronted by a powerful fleet, as the guardian to the entrance of the archipelago. It is doubtful if Russia would take this chance.

The Baltic is therefore the only active fleet of Russia, it is in fact a European fleet, with which an enemy will have to contend. The relation of the different parts is satisfactory, the ratio of battleships to cruisers is good, and the number of sea-going torpedo-boats is great; while the coast defense represents considerable strength. Selecting only those torpedo-boats of the greatest tonnage and highest speed with suitable armament (the largest Russian torpedo-boats have a displacement of more than 100 tons, run 21 knots, and carry 37-mm. R. F. guns), two can be attached to each battleship, which would form part of a squadron or group. The eight cruisers have sufficient speed and protection to form an effective homogeneous squadron for scout and despatch service. Should it become necessary to detach a squadron of one battleship and three cruisers for service in the Mediterranean, the fleet would be materially weakened, which has led many to earnestly recommend to keep the entire force in northern waters, where it could play an important part against the fleets of the Triple Alliance. This condition will only continue until the vessels now building are completed. When these have been added to her Navy, Russia will possess an effective force, not only to take an active part in the North, but also to send a strong division to operate in the Mediterranean. In the event of an alliance between Russia and France, the latter would have the greatest interest in the composition of this fleet. At present, France is deficient in cruisers, therefore it would be to her benefit if this division for service in the Mediterranean were entirely composed of cruisers. France has more battleships in the Mediterranean than Italy and Austria combined.

In the North, the Russian fleet will only have to overcome the naval strength of Germany.

Although it is flattering to France not to feel herself isolated in the Mediterranean any longer, she should not forget one weak point in this combination. The Baltic is closed by ice for six months, and from November to April navigation is suspended. Should therefore war be declared in March, Germany would have nothing to fear from the Russian battleships, cruisers and

torpedo-boats blockaded in Cronstadt. This annual immobility of the Russian fleet will cease as soon as the harbor of Libau becomes as important and complete a navy yard as Cronstadt. This harbor, in the southern part of the Baltic has the advantage over Cronstadt that it never freezes.

The completion of this naval establishment will increase Russia's Naval power materially, as her fleet will be able to take the sea at all seasons of the year. Russia will then not have merely a window from which she can oversee Europe as Peter the Great wished, when he wanted to drive the Swedes from Finland, but also a door through which she can pass at her will. From that day when her fleet will be independent of the seasons and weather, her co-operation in the North can be depended upon.

It is an indisputable axiom that wars of the future will be decided by short and decisive battles, all navies therefore are making strenuous efforts to place their fleets in the highest state of efficiency for war, especially the battleships. This readiness for war is of such importance that a certain navy of the Triple Alliance, notwithstanding the excellence of its material, finds itself in a condition of inferiority, because means have not yet been devised to concentrate the personnel to man her powerful and swift battleships in an emergency. Russia, in this respect, is in a very favorable condition. To man her Baltic Sea fleets, she has 10,000 men, and for those of the Black Sea, 3500 men at her command. In the Baltic marine divisions, called equipages, there are 18,000 men, exclusive of the coast guard which numbers 2000 men. In the Black Sea, these divisions number 6000 men, she has therefore a considerable surplus over the complement necessary to man her fleets.

The above details and observations apply only to the case of war between fleets. Russia is deficient in cruisers to make war on commerce. Her cruisers protected and armored, have only an average speed of from 12 to 14 knots, which is entirely insufficient. Of course, in case of war a number of fast merchant steamers would be converted into auxiliary cruisers. Russia has in this respect an organization peculiar to herself, from which, in the event of war, she will secure a number of auxiliary cruisers. This institution is her "Volunteer Navy," which dates back to the time of the Treaty of Berlin, when a war with England was feared. A national subscription, headed by the present Czar, at that time Grand Duke, collected in a few days a sum sufficient to purchase seven mail steamers. This voluntary fleet had the contract of all government traffic between Odessa, Vladivostock and Saghalien, and was subsidized. In addition to this, it had the privilege of manning its steamers with officers and men of the Imperial Navy. It was, therefore, something between a merchant and a war fleet. Notwithstanding its close relation to the State, it still retained its character as a private venture. It carried on commerce with all the ports along the route, and has become the greatest importer of tea from China. Its revenues at present are very great. Encouraged by its success, the government has decided on a considerable increase of this fleet. To the original seven vessels, two have been added, and eleven more, with a speed of 20 knots, and constructed with a view to conversion into auxiliary cruisers, will be added.

This review of the naval strength of the Russian Empire would be incomplete without a consideration of her naval ports. Of these she has twelve; five harbors of the first class: Cronstadt, St. Petersburg, Nicolaieff, Sebastopol, and Vladivostok; and seven of the second class: Sweborg, Reval, Archangel, Baku, Batum, Nicolaijefks on the Amur River, and Kagala on the Oxus. The harbor of Libau was only recently inaugurated, and with great ceremony —indication of the importance of this new central naval station.

Most of the Russian ports are well defended. The coast defense of the Baltic is well organized. In this sea, whose coast possesses a natural defense in its difficult approach from the ocean, the best defended ports are Dünamünde, Cronstadt, Wiborg and Sweborg.

Cronstadt cannot be taken; with its cross-fire from armored forts, which

command its approaches for twenty-nine miles, it can repel every bombardment from the sea.

In the Black Sea, Sebastopol has lately been fortified. Kertsch and Yenikall are also strongly defended; Nicolaieff, Knibum, Otchakoff are surrounded by numerous fortifications; Azov, Batum and Poti are receiving heavy armaments.

The ships for the Russian Navy are built at St. Petersburg, either at the Imperial dockyards, or at the Baltic shipbuilding establishment. The latter, though a private concern, is nearly entirely controlled by the government.

At Abo, Finland, the Navy has an important establishment, where smaller ships and torpedo-boats can be built. At Cronstadt there are only repair shops and store houses. In the South, at Nicolaieff, the government has a navyyard of the first rank.

Private establishments also build for the Russian Navy. The Franco-Russian shipyard, a thoroughly French establishment, which built the Kaiser Nikolaus and cruiser Rynda, part of Admiral Avellans' squadron, is at present building for the Russian Navy.

The establishments of the Black Sea Company, near Sebastopol, as well as those at Pontiloff and Tiora frequently do work for the Navy.

Occasionally the Russian government also has ships built in foreign countries. One of her best cruisers, the Admiral Korniloff, was built on the Loire, and different torpedo-boats were constructed by Normand at Havre. The greater part of her torpedo material was built at the Schichau works, at Elbing. From these contracts with foreign establishments an unfavorable opinion of Russian industry must not be inferred. In this manner she obtains models to be reproduced or copied. The Russian shipbuilding works are in the best condition (though the cost of building is relatively high), and vessels launched there compare favorably with the best of other navies. The progress of Russian industry is shown in that she now produces her artillery material at the works at Oboukhoff, whereas a few years ago she procured her guns from Krupp.

This is the condition of the Russian Navy to-day. It is deficient in ships, and has no reserve, but in the near future it will possess both. It is developing rapidly. Russia was the first country in the Crimean war to use torpedoes, at that time called Jacobis after the inventer; and she was also the first to build monitors; she adopted sea-going torpedo-boats about the same time as Germany. Lately she has placed herself at the front of all navies in the construction of powerful cruisers, which will in all probability play a conspicuous part in future naval wars. This activity is an indication of great strength.

In this age of never ending war between industry and science, a navy to progress must march with the times. This the Russian Navy does.

The best material, the heaviest armament, and the greatest speed are worthless unless in the hands of an efficient personnel.

"*Tant vaut l'homme, tant vaut la terre*" says the landsman. "*Tant vaut l'homme, tant vaut la flotte*," the sailor might say.

In Russia the sailor has not as much practical exercise in his profession as desirable. Taken from a village in the interior of the empire, he passes the greater part of his service as a barrack soldier, performing only a few months' sea duty, during the season when the Baltic fleet can be commissioned for service. He is practiced in military service, but in that knowledge and experience of a sailor which can only be acquired at sea, he is generally deficient. Still, since in the modern ship masts and sails have disappeared, and all is sacrificed to military apparatus, it cannot be said that the Russian sailor will not prove himself a worthy opponent. Above all, it must not be forgotten that with the opening of the harbor of Libau, the conditions will change. Then you will not have the fleet blockaded in the ice for six months of the year. This navy yard is destined to be Russia's principal station in the Baltic, and when completed, the Russian sailor will acquire that experience in ship life in which he is now deficient.

The officers, on the contrary, have always found opportunities in their career to improve themselves in practical navigation, and to acquire the necessary nautical knowledge and experience. They truly deserve the name of seamen, and are, above all, well informed in every branch of their profession.

SHIPS OF WAR.

THE UNITED STATES.

THE MAINE.

The official trial of the battleship Maine took place in Long Island Sound October 17. The hull of the Maine was constructed at a navy yard by the government and machinery furnished by contractors. The run was made in a stiff westerly wind. During the four hours' run, under forced draught, the general average of the steam pressure was 141 pounds, the propellers making 127 revolutions a minute. The average speed was 15.95 knots per hour. To this a tidal allowance of 1¼ knots must be made, so that the total speed was 17.2 knots or possibly 17.25 knots. The engines, which were built by the Quintard Iron Works, made from 400 to 600 horse power more than the 9000 called for by contract, so that a handsome premium may be expected. The temperature in the boiler and engine-rooms was very high. In the engine-room at the cylinders the thermometers registered at times 180 degrees, in the boiler-room the temperature varied from 110 to 115 degrees. The Maine is the first completed battleship of the new navy. She was launched November 18, 1890. She is 324 feet 4½ inches long; has 57 feet beam, and 21 feet 6 inches draught. Her displacement is 6682 tons. She carries 12-inch armor and will mount four 10-inch guns and six 6-inch rifles. She has a fine supplementary battery. The ship has twin screws, each 15 feet in diameter. She can carry 822 tons of coal, and with that amount can steam 4250 miles at a 10-knot speed.

TORPEDO LAUNCH FOR THE MAINE.

Four of these boats of similar construction are to be built, two for the battleship Maine and two for the Texas. The machinery for the boats for the Maine has been built at the New York Navy Yard, and was tested on the shop floor with very gratifying results. The engines for the boats of the Texas are under way. The Maine launch measures 61 ft. 8 in. over all, has 9 ft. 1½ in. beam amidships and draws only 26 in. of water. Her total weight ready for service, is 15⅝ net tons, of which about 3 tons is coal and stores. Her engine is quadruple-expansion, a decided novelty for so small a craft. The frames of the hull are chiefly of angle-irons. The boat is decked over for its whole length, save between frames 14 and 19, and frames 39 and 47; these spaces form water-tight cock-pits for the crew. The hull is divided transversely by six bulkheads, forming seven water-tight compartments. Fore and aft trimming tanks are provided. The boat has high freeboard and plenty of stability.

The weapons are a bow torpedo tube, and a 1-pdr. rapid-firing gun, mounted at the stern. At the rear the torpedo tube extends into a small conning tower. The chamber for loading the torpedo tube is immediately below this tower and back of the collision bulkhead. Aft of the tower is a cock-pit with a provision bin below it and a fresh-water tank on each side, from which the boilers are supplied.

The boiler compartment can be closed air-tight for working with forced draught and a ventilating pipe with large cowl supplies air for natural draught. The engine compartment is back of the boiler-room and separated from it by

a tight bulkhead. This room can also be closed air-tight when desired, and is then lit by a deck light. The coal bunkers are on each side of the boiler and engine-rooms, and water-tight doors connect the bunker space beside the engine-room and that beside the boiler-room. The ammunition department is behind the engine-room and communicates with the rear cock-pit by a water-tight door. The rudder can be worked by a tiller in the rear cock-pit, in case the ropes from the pilot tower should break or fowl.

The Whitehead torpedoes weigh in all more than 2100 lbs., and as this weight is placed rather high above the waterline, it had to be counteracted by placing the heavy machinery as low as possible. The stability of the boat when ready for action, with torpedo munitions and crew, is as follows:

Metacentric height, inches	18 19-32
Inclination at greatest stability	43°
Inclination at limit of stability	89°
Moment at greatest stability, ft. lbs	27,135

The very high boiler pressure of 250 lbs. was adopted, and it was decided to keep down weights by the use of a tubulous boiler. The boiler of Mr. C. D. Mosher was the one adopted. As installed in this little vessel it consists of two upper and two lower horizontal cylinders, connected by 440 drawn steel tubes 1 in. in diameter, and of a thickness corresponding to No. 15 B. W. G. The boiler can develop 200 to 250 H. P. under forced draught. It has 13 sq. ft. of grate surface and 513 sq. ft. of heating surface.

A flap damper is hinged in the ashpan in such a way as to permit free entrance of air, but to close automatically in case a sudden outrush of steam should occur from the bursting of a tube, and thus prevent blowing the fire out into the boiler-room.

The engine is designed to develop about 200 H. P. with 250 lbs. of steam when making 675 revolutions. Piston valves control the steam supply, except to the low-pressure cylinder, where a double-ported slide valve is used.

The condenser is entirely of composition, and has about 150 sq. ft. of cooling surface. The vacuum is maintained by two single-acting air pumps, driven by gearing from the forward end of the main shaft. The circulating pump is of the centrifugal type, but is only designed to take care of steam blown off when the boiler is idle. When the vessel is in motion, the circulation is maintained by scoops over the injection and the outboard delivery.

There are two smoke pipes, each 11⅛ in. inside and 12 ft. 6 in. above the grate. These pipes are double, with a 1½ in. air space between the outer and inner shell, open at top and bottom for free circulation.

The propeller is composition metal, 36 in. in diameter and 39 in. pitch, with a helicoidal area of 4.1 sq. ft. The propeller shaft is hollow, 3 in. in diameter outside and 2¼ in. inside. The stern tube is a 4-in. steel tube, lined with white metal, and with a hemp-packed stuffing-box in the forward end. The shafts are all of forged mild steel. The piston rods and valve stem are of mild steel, oil-tempered and ground.

The smallest engine on board the vessel is that which drives the centrifugal circulating pump. Its cylinder is 2 in. in diameter and 1½ in. stroke. For keeping the bilges clear, the suction of both feed pumps can be connected with the bilge, and there is also a steam ejector in the fire-room leading through the side of the boat at the waterline with a capacity of about 11 tons per hour. The blower in the fire-room is capable of supplying sufficient air to burn coal at the rate of about 720 lbs. of coal per hour. The engine-room and fire-room are floored with 1-16-in. iron plates, with flat-topped corrugations.

The boat is expected to attain a speed of 18 knots with the engines developing 200 H. P. At a fuel consumption of 1⅝ lbs. per H. P. hour, which, it is claimed, the engine can attain at full speed, this would mean a consumption of about 333 lbs. per hour, and the bunker supply would permit a full speed

run of about 120 miles. At an ordinary cruising speed of, say, 10 miles per hour, it is expected that the coal consumption per horse-power will be still lower, and that the vessel will be able to make some 400 miles without recoaling.

TORPEDO-BOATS 3, 4 AND 5.

The leading features of the proposed new torpedo-boats, in comparison with those of the Ericsson, are shown in the accompanying table:

	Ericsson.	New design.
Length on load water line...	150 feet.	160 feet.
Beam on load line.....	15.5 feet.	16 feet.
Mean draft.....	4.75 feet.	5 feet.
Displacement.....	120 tons.	135 tons, about.
Indicated horse-power (est.).	1800.	2000.
Speed per hour (est.). ...	24.	24½.
Coal capacity.....	40 tons.	50 tons.
Armament.....	One bow tube.	Three deck tubes.
	One twin deck tube.	Three 1-pdr. R. F. guns.
	Four 1-pdr. R. F. guns.	

The various weights in tons are to be as follows:

	Ericsson.	New Design.
Hull and fittings.....	48.54	54
Engineers' weights.....	51.76	60
Ordnance weights.....	5	5.5
Coal.....	9	9
Boats, electric plant and miscellaneous.....	5.70	7
Totals.....	120.00	135.5

There will be two boilers of the sectional coil or tubulous type. The total grate surface will be at least 95 square feet, and the total heating surface at least 5120 square feet. Efficient means must be provided for getting at the interior of such parts of the boiler as require attention for examination, cleaning or repair. They will be built for a working pressure of at least 250 pounds per square inch. Each boiler will be placed in a water-tight compartment, one being forward of the engines and the other aft.

The propelling engines will be alike, and each will be placed in a separate water-tight compartment. These engines will be of the vertical inverted cylinder, direct-acting, triple-expansion type, each with a high pressure cylinder 12 inches in diameter, an intermediate pressure cylinder 19¼ inches in diameter, and two low pressure cylinders each 22 inches in diameter, the stroke of all pistons being 16 inches. The indicated horse-power of propelling engines will be about 2000, when the engines are making about 412 revolutions per minute. The high-pressure cylinder will be aft in the starboard engine and forward in the port engine, and the low-pressure cylinder will be forward in the starboard engine and aft in the port engine. The four cylinder casings of each engine will be made in two castings, the high and intermediate-pressure forming one and the two low-pressure cylinders the other.

The main valves will be worked by means of cranks on a shaft parallel to the main engine shaft, and geared to that shaft. All the main valves will be piston valves, there being one for each high-pressure, two for each intermediate-pressure and two for each low-pressure cylinder. The valves will not have any packing rings, but all will be turned and polished with emery to fit their cylinder liners accurately.

Each main piston will have one piston rod, with a cross-head working in a slipper guide. The pistons will be of cast or forged steel, finished all over, and will be dished. Each piston will have two packing rings, each ¾ inch

wide, and ⅝ inch thick, of hard cast iron, cut obliquely and tongued. The packing rings will be sprung in without followers. The piston rods will be hollow and made of forged steel, oil-tempered. The framing of the engines will consist of vertical forged steel columns well stayed by diagonal braces. The engine bed-plates will be of plate steel, supported on wrought steel keelson plates built in the vessel. The crank shafts will be made in one section, and will be hollow.

There will be two condensers made entirely of composition and sheet brass. Each will have a cooling surface of about 800 square feet, measured on the outside of the tubes. For each propelling engine there will be a single acting air-pump driven from the main engine shaft. The circulating pumps will be of the centrifugal type, one for each condenser. There will be one single acting inclined trunk air-pump for each engine, worked by an eccentric on the main shaft. The propellers will be right and left, of manganese bronze or approved equivalent metal.

The connecting rods with their bolts and caps will be of forged steel, finished all over, and oil-tempered.

All the crank, line, thrust and propeller shafts will be of forged steel. Each length will be forged solid in one piece.

ENGLAND.*

THE ARDENT.

[*Engineering.*]

On November 9 a trial of the torpedo-boat destroyer Ardent was made; she is the first of three sister vessels which have been built by Messrs. J. I. Thornycroft & Co., of Chiswick, to the order of the Admiralty. The torpedo-boat destroyer class, like all other types in the Royal Navy, is still growing; the new vessels, of which the Ardent is the first, are 15 ft. longer than the destroyers Daring and Decoy, lately completed for the Government by this firm. The engines are similar to those of the Daring. The Ardent is, therefore, 200 ft. long, 19 ft. wide, and 14 ft. deep, the latter dimension being 1 ft. greater than in the Daring and Decoy. The vessel is twin-screw, and the engines are of the three-stage compound type, having cylinders 19 in. in diameter, and 27 in. in diameter for the high and intermediate-pressure cylinders respectively, whilst there are two low-pressure cylinders to each set of engines, each of which is also 27 in. in diameter. The boilers are of the Thornycroft type, similar in general design to those of the Daring. In the Daring's boilers there are two close walls of tubes forming the exterior of the furnace space or combustion chamber; the products of combustion passing to a space, or uptake, in the center of the boiler between the two furnaces. In the Ardent's boilers the same outer rows of adjacent tubes are retained, but bent inwards towards the furnace space is a row of other tubes, which, however, are not touching each other, so that the heated gases can pass between them to the walls of tubes at the back. In this way an addition has been made to the heating surface, and, though the back tubes are somewhat masked, the arrangement has resulted in more steam being generated, with a corresponding increase in power developed by the engines.

The trial was of a preliminary nature, the official trial, with all weights on board, being yet to be made. Occasion was taken, when making the preliminary trials of the Daring, to get runs at progressive speeds, and the same course was followed with the Ardent in order to get further evidence bearing upon the performance of these vessels. The Daring made 7.86 knots at 91 revolutions, 14.2 knots at 175 revolutions, 18.3 knots at 238 revolutions, 23.4 knots at 322 revolutions, and finally 28.656 knots at 384.3 revolutions, the

* Details of foreign ships when not otherwise noted are from *Engineer* and *Engineering*.

steam pressure being 200 lbs., and the power 4842 indicated horse-power on the latter run.

The table gives the results obtained with the Ardent.

It will be seen, therefore, that the Daring's speed has been exceeded by the later and longer vessel, but it has required an increase of power for the purpose, the Ardent's engines giving about 5000 horse-power on the last pair of runs.

The absence of vibration, which has been so happy a characteristic of the later vessels of this class was also noticeable in the Ardent, whilst another improvement was the very small amount of flame to be seen at the tops of the chimneys, even when running at highest speed.

H. M. S. ARDENT, AT THE MAPLIN, NOVEMBER 9, 1894.

WITH NATURAL DRAUGHT.

Number of Run.	Steam.	Receiver Pressure.		Vacuum.	Revolutions.		Time.	Speed.	Mean Speed.
		M. L.	L. P.		Port.	Starboard.			
	lbs.	lbs.	lbs.	in.			m. s.	knots.	knots.
1	110	42	10	27	280	277	2 48	21.429	
2	85	40	9	27	269	268	3 22	17.322	19.275
3	90	39	8	27	272	269	2 51.2	21.028	
With ½ in. Air Pressure.									
1	160	80	24	26	355	351	2 21.8	27.314	
2	167	84	27	26	370	368	2 19.6	25.789	26.787
3	160	78	26	25	368	366	2 7.4	28.258	
With 2 in. Air Pressure.									
1	200	100	43	24	411	408	2 7.6	28.214	29.182
2	195	95	41	24	407	405	1 59.4	30.151	

THE HAZARD.

Under the Naval Defense Act there were included five vessels of an improved Sharpshooter class, named Halcyon, Harrier, Hussar, Hazard and Dryad, laid down in the financial year 1892–93 in the dockyards, but supplied with machinery by contract. All the vessels were alike, and were made larger than the Sharpshooters, so that greater scope could be given to the engineer in the design of boiler to obviate the disastrous results which befel the Sharpshooters, with few exceptions, when they were subjected to forced draught conditions. The length of the new vessel is 250 ft. instead of 230 ft., the beam is 30 ft. 6 in. instead of 27 ft., and the depth 9 ft. instead of 8 ft. 3 in., the displacement having been increased from 735 tons to 1070 tons. This great increase is largely due to the additions to the boiler power, since the armament is the same—two 4.7-in. and four 6-pounder quick-firing guns. The weight of hull in the case of the new vessel is 555 tons, which is about 180 tons greater than the Sharpshooter class. The new vessels have a slightly greater freeboard, and are altogether a more comfortable and seaworthy class, besides being more reliable in the matter of speed, and are well worth the extra 20,000*l.* spent upon them, the cost of each, including machinery, having been 75,000*l.* The radius of action is the same—2500 miles at 10 knots.

The Hazard, built at Pembroke, and engined by the Fairfield Company, has been completed, and passed successfully through her speed trials. The requirements were 3500 indicated horse-power under forced draught, and

2500 indicated horse-power under natural draught, the corresponding speeds of the gunboat being 19 and 17.5 knots respectively. The propelling machinery consists of two sets of triple-expansion engines, fitted in two separate engine-rooms, each set having three inverted cylinders and three cranks. The high-pressure cylinders are 22 in. in diameter, the intermediate-pressure cylinders are 34 in. in diameter, and the low-pressure cylinders are 51 in. in diameter, and each is adapted for a stroke of 1 ft. 9 in. The high pressure cylinders are fitted with piston valves, and the intermediate and low pressure cylinders are each fitted with a double ported slide valve; all being worked by the ordinary double eccentrics and link-motion valve gear. The reversing engines are of the all-round type, with worm and wheel gear. The columns are all of forged steel, and the engines are so arranged that the starting platforms are in the center of the ship. The condensers are of brass, and placed alongside the engines, the steam being condensed outside the tubes, the circulating water passing through the tubes. The circulating pumps are centrifugal, and driven by independent and separate engines. The feed, bilge, and fire engines are all independent of, and separate from the main engines; steam being supplied by a special range of pipes. The crank, tunnel, and propeller shafting is of forged steel and hollow throughout. The propellers are of gun-metal. Each has three adjustable blades and works outwards.

Steam is supplied by four boilers of the modified locomotive type. They are 15 ft. 9 in. long. Each has two furnaces. The fire-box is of steel, as are also the tubes, the length of the latter being 7 ft. 1⅛ in., and the external diameter 2 in. The pressure is 155 lbs. per square inch. The boilers are arranged in two boiler-rooms, one forward and one aft of the engines, and the steam pipes are so arranged that the steam from the boilers in either boiler-room can be used for the engines in either or both engine rooms. The boiler-rooms are fitted with fans and engines so arranged that they can be closed and worked under forced draught when desired. We give the detailed results of the speed trials.

PARTICULARS OF EIGHT HOURS' NATURAL DRAUGHT TRIALS.

	Revolutions.		Indicated Horse-Power.		
Hours.	Port.	Starboard.	Port.	Starboard.	Total.
1....	227.0	230.5	1183	1488	2671
2....	218.0	217.3	1179	1188	2367
3....	221.0	219.2	1106	1157	2263
4....	230.0	231.4	1259	1363	2622
5....	234.5	236.5	1410	1416	2826
6....	224.9	242.0	1353	1515	2868
7....	221.8	238.6	1284	1438	2722
8....	229.3	232.2	1364	1267	2631
Means..	228.0	230.9	1267	1354	2621

THREE HOURS' FORCED DRAUGHT TRIALS.

	Revolutions.		Indicated Horse-Power.		
Half-hours.	Port.	Starboard.	Port.	Starboard.	Total.
1....	260.0	266.0	1791	2000	3791
2....	263.0	266.0	1879	1995	3874
3....	262.0	265.5	1844	2009	3853
4....	263.8	266.3	1918	2054	3972
5....	265.2	257.4	1881	1871	3752
6....	245.0	242.0	1508	1654	3162
Means..	268.4	260.5	1803.5	1930.5	3734

It will therefore be seen that under natural draught the mean results were: Steam in boilers, 137 lbs.; vacuum, starboard, 24.6 in.; port, 25.5 in.; air pressure, .82 in.; indicated horse-power, 2621; speed by log, 17.5 knots. On the forced draught trial the mean power developed was 3734 indicated horse-power, the speed by log having been about 19¼ knots.

FRANCE.

ALGER AND ISLY.

The dimensions, etc., of the Alger are as follows:—Length, 364 ft.; beam, 45 ft. 3 in.; draught, 19 ft. 6 in.; displacement, 4122 tons; indicated horse-power, 8254; maximum speed, 19.61 knots; coal capacity, 860 tons. The Alger has no vertical armored protection, but a curved steel armored deck runs from stem to stern, and this is 3½ in. thick—far stouter than that allowed in British cruisers of equivalent displacement, the Astræa type. The armament of the Alger is, moreover, immeasurably more powerful than that of the Fox or Astræa. She carries four 16-cm.—6¼ in.—and six 14-cm.—5½ in.—quick-firing guns as a main armament, against two 6-in. and eight 4.7-in. of similar type in the British vessels, and ten smaller quick-firers, with ten machine guns and four torpedo tubes. But what adds very considerably to the effective gun power of the Alger and Isly is the fact that all their eight heavy broadside guns are in protected sponsons, so that an overwhelming end on power can be obtained when necessary.

The Alger and her sister ship the Isly, have a high freeboard, in this respect resembling the four large cruisers which are doing such excellent work for the Japanese at this moment, and her coal bunker divisions are so arranged as to add immensely to the security afforded by the armored deck. The conning towers are thickly armored, and shelter decks are over all the upper deck gun positions. The fighting masts are of large size, with double staircases, and search lights in the upper tops. The Isly attained a speed of 16.8 knots with natural, and 18.1 knots with forced draught, whilst her trials were being made in an exceptionally heavy sea.

AN ALUMINIUM TORPEDO-BOAT.

The boat weighs ten tons with steam up and coal in the bunkers; is capable of twenty and a half knots speed and 300 horse-power. It has not yet received either a name or an official number, yet is the largest vessel yet built of aluminium. Indeed, she is the largest structure of any kind yet produced in that metal, a small yacht and an arctic boat being her only predecessors. The torpedo-boat is of the second-class. She is 60 ft. long, and 9 ft. 3 in. beam. Thus she has 9 in. more beam than the English 60 ft. boats, a most important improvement in many respects. The object of what is termed a second-class torpedo-boat is to be carried on the deck of large men-of-war, to be lowered in the water and to act, when necessity requires, as a scout, to watch the movements of the enemy's torpedo-boats, or for the use of the ship for landing and embarking the officers. The ordinary armament of a second-class torpedo-boat consists of one or two machine guns placed forward and a torpedo launching tube aft.

It is self-evident that lightness of construction is of paramount importance in craft of this kind, not only because reduced displacement secures increased speed, but, considering that the boat has to be lifted and low-

ered by the tackle available on board the ironclad or other vessel, it is clear that the weight to be handled should be reduced to a minimum. Moreover, as these boats are placed high up on a ship's deck, any reduction of top weight increases the stability of the ship to which they are attached. In the English Navy a large number of these second-class torpedo-boats is used to form part of the standard equipment of all men-of-war. The French naval authorities, however, up till last year had not adopted them, and, as they were desirous of introducing them into their Navy, they invited tenders for the best torpedo-boat of this class which modern improvements enabled constructors to build, to serve as a type to be followed in the future. The primary conditions imposed were good sea-going qualities and lightness, combined with the highest obtainable speed. The proposal submitted by Messrs. Yarrow & Co. was the one accepted, as they were prepared to guarantee a higher speed and lighter weight to be lifted than any other firm, mainly in consequence of having determined to adopt aluminium for the construction of the hull. The boat illustrated is the first aluminium vessel built for the French government.

Comparatively little has hitherto been known about aluminium as a structural material, and before adopting it Messrs. Yarrow & Co. carried out a series of elaborate experiments on the metal to obtain information. The great and uniform success of this firm in all their ventures is largely due to the elaborate system of experimenting carried out at Poplar. The trials of aluminium referred to its stiffness, best working temperature, corrosion, etc. It was found, in the first place, necessary to alloy the metal, by which its tensile strength was raised from 9 tons per square inch to about 18 tons. The alloy is mainly 6 per cent. of copper. As regards stiffness, etc., a general result was arrived at. All scantlings were increased 25 per cent. over that allowed for steel, and as aluminium weighs about one-third of steel, it follows that a reduction of about one-half was effected in the weight of the hull, which was reduced from about four tons for steel to about two tons for aluminium. In order to arrive at some precise information concerning corrosion, two aluminium plates were accurately weighed, and then secured on the sides of a wooden coppered sailing ship, the copper being removed and replaced by the aluminium. This ship made a voyage round the world, then the aluminium plates were removed, weighed, and found to have suffered no appreciable loss. The great foes to aluminium are alkalies, which attack it powerfully, and heat. It fuses at a moderate heat, and loses much of its strength at comparatively low temperatures. In the case of a torpedo-boat there is no trouble incurred in avoiding both sources of risk. No plates or angles were touched by the fire; everything was bent cold. The frames are a little closer together than they would be if of steel. The extra cost of material in the use of this particular boat being $5000 as compared with that of steel. In return there is a saving of about two tons in weight, and a gain of about 3½ knots in speed over vessels of the same class and dimensions in the British Navy which steam under the like conditions at 17 knots. The boat is built the usual way, and triple-riveted with aluminium rivets. Her machinery consists of a set of triple expansion engines, driving an aluminium bronze propeller at 580 to 600 revolutions per minute. These engines are balanced without bob weights, on Mr. Yarrow's principle, at two points only, the balance weights being fitted at properly calculated angles to the cranks. The boiler is of the ordinary Yarrow water-tube type.

The official trial took place on the 20th of September, the French Government being represented by a Commission.

Official Trial of Aluminium Second-class Torpedo Boat for the French Government by Yarrow & Co. Dimensions, 60 ft. by 9 ft. 3 in.

The trial consisted of a continuous run of two hours' duration in the estuary of the Thames. Weather, calm; number of persons on board, seventeen; total load on trial, three tons.

No. of run.	Steam in boiler.	First receiver.	Second receiver.	Vacuum in condenser.	Air pressure in stokehold.	Revolutions per minute.	Time on knot.	Speed.	First means.	Second means.	Mean of means.
				in.	in.		M. S.				Knots.
1	185	72	12	24	2½	600.36	2 42	22.222			
									20.893		
2	185	72	12	24	1½	598.80	3 4	19.565		20.807	
									20.721		
3	175	72	12	24	2½	593.40	2 45	21.877		20.566	
									20.412		20.503
4	175	62	11½	24	1½	578.16	3 10	18.947		20.299	
									20.187		
5	180	65	11	24	1½	586.80	2 48	21.428		20.341	
									20.496		
6	185	70	12½	24	1½	591.48	3 4	19.565			

During the trial of two hours' duration the engines made 70,948 revolutions, being at the rate of 591.2 revolutions per minute, corresponding to a mean speed during the entire run of 20.558 knots per hour. The boiler—Yarrow's patent water-tube—made ample steam without priming, and the engines worked without any heating. The vibration was very slight, and not appreciable.

During all the trials of this boat, the absence of vibration and of noise in the engine-room has been most noteworthy. She has been run at various speeds from dead slow up to the highest attainable, and at none has the slightest vibration been felt in any part of the boat, forward, aft, or amidships. The only thing of the kind perceptible was a species of purring thrill. Part of this is no doubt due to the construction of the engines; but much remains to be explained by the metal. Although aluminium is in some forms one of the most sonorous in existence, in the shape of a torpedo boat it is wanting in that resilience and vibratory stiffness peculiar to steel. This largely explains the comparative silence of the engines. In a thin steel hull every sound is magnified, in the aluminium boat it is deadened—the new metal behaving apparently very much like wood.

GERMANY.

THE WÖRTH.

[*Marine Rundschau.*]

The new 1st class battleship Wörth which is flying the flag of Admiral Baron von der Golz, the commanding admiral of the German Navy during the manœuvres, has lately completed her trials most satisfactorily. She is one of a class of four ships peculiar to the German Navy, as they have three turrets, in each of which two heavy guns are mounted, instead of the two turrets, or barbettes, in which the heavy armament of modern battleships is usually carried; the other three sister ships are the Brandenburg, which also forms part of the manœuvre fleet, and the Weissenburg and Kurfürst Friedrich Wilhelm, both of which are approaching

completion. Their dimensions are as follows: length, 354 ft. 4 in., beam, 64 ft., and with a displacement of about 10,000 tons, they have a mean draught of water of 24 ft. 7 in.; the engines are to develop 9000 I. H. P., and to give a speed under forced draught of 16 knots. The armor protection consists of an all-round water-line belt of nickel steel, 16 in. thick, but tapering at the bow and stern to 12 in.; the turrets are also protected with 12-in. armor, while the armored deck is 2.8 in. thick. The armament consists of six 28-cm. (11.2-in.) guns, six 10.5-cm. (4.1-in.) and eight 8.8-cm. (3.5-in.) Q. F. guns, and 10 machine guns. The six 28-cm. guns are mounted in three barbette turrets with steel hoods, the foremost of which permits the guns to be fired over the forecastle, from right ahead to about 45° abaft the beam; of the two after barbettes, the one on the quarter-deck has an arc of training fore and aft of about 90°, while the after one has an arc from right astern to about 45° before the beam; the six 10.5-cm. Q. F. guns are mounted in a central battery abaft the foremost barbette; the two foremost 8.8-cm. guns are in armored sponsons forward, two others are also mounted in afterpart of superstructure forward, while the remaining four are mounted in the superstructure aft, and have an arc of training from right astern to well before the beam; there are also six above-water torpedo-discharges. The trials of the Wörth began in November of last year, and were brought to a conclusion last May; in a moderate sea, which the ship experienced between Christiansöe and Rixhöft with the force of the wind 8, she rolled 15° both ways, once or twice going over to 20°; the pitching was slight and easy. The ship answers her helm readily, although her displacement is heavy. She was, when steaming 15 knots, brought to a dead stop in two minutes with both engines going full speed astern. The highest speed attained by the Wörth was 17.2 knots with 111 revolutions of the screws off Bornholm, where there was 30 fathoms of water; with the same number of revolutions in the Eckernförder Bay she made 16.9 knots, and in the Bay of Danzig, where there was only 20 fathoms of water, the speed was only 16.5 knots. The least number of revolutions of the engines was 18, which gave a speed of three knots; there was at no time, even when going full speed, any appreciable vibration. From the beginning to the end of the trials there does not seem to have been the slightest hitch, and how satisfactory the trials proved is shown from the fact that although the contract I. H. P. was only 9000 H. P., with an estimated speed of 15.5 to 16 knots, yet the H. P. actually developed was 10,228, with a corresponding speed of 17.2 knots. The accommodation for officers and men, of which her complement is 552, is also very good, and the ventilation excellent.

THE ARGENTINE REPUBLIC.

THE PATRIA.

[*Engineer, September 14.*]

The Argentine cruiser Patria, built and engined by Messrs. Laird Bros., of Birkenhead, has been put through her official speed trials with eminently successful results, the procedure of the trials being similar to that laid down by the British Admiralty, armament and all normal weights on board.

The full power forced draught trial of three hours' duration was made on the Clyde last Friday week, six runs over the Skelmorlie mile giving a mean speed of 20.575 knots, with a mean of 233.4 revolutions per minute,

whilst the record for the three hours' continuous running was 20.56 knots, with a mean of 233.5 revolutions—this exceeding by one knot the guaranteed speed of 19.5 knots. Nothing could have been more satisfactory than the working of the engines and boilers, and the almost entire absence of vibration of machinery and in the ship.

The official natural draught trial was made in Liverpool Bay the week before, during boisterous weather and with a heavy cross sea, when, during eight hours' continuous steaming, 17.6 knots, and with 201 revolutions, during six consecutive runs over the base between the outer lightships, 17.915 knots were recorded. The ships are 8.1 knots apart, in exposed positions, and form necessarily a difficult course to steer accurately; the speed, however, was one quarter knot over contract. In order to test this a further natural draught trial was made on Friday last, when four runs were made over the Skelmorlie mile at 190 revolutions—which it was estimated would give 17.5 knots, the contract speed—with the result that 17.772 knots was recorded, with 11 revolutions per minute less than when running the trial in Liverpool Bay.

The Patria is a cruiser similar to the Halcyon and Harrier class, of which some half-dozen are being added to the British Navy, but, on the recommendation of Messrs. Laird, the Argentine Government decided to have the poop and forecastle joined, forming a complete spar deck, which adds much to the general comfort and seaworthiness, makes it possible to place the broadside guns fully 7 ft. higher above water, and affords accommodation available for the carrying of troops or reliefs when required, whilst the larger engine power gives a knot per hour greater speed. The principal dimensions are:—Length, 250 ft.; beam, 31 ft. 6 in.; draught of water, with armament and all normal weights on board, 10 ft.—the screws do not project below the line of keel—bunker capacity for 250 tons of coal, or 4000 knots range of action.

The machinery consists of two sets of tri-compound engines. The main condensers, evaporators, and distillers are of brass, and the auxiliary machinery and general arrangements are similar to the builders' well known type of high speed engine, of which the Rattlesnake was the original. The boilers are four in number, of the dry bottom locomotive type, worked on the closed stokehold system, the air pressure for full power not exceeding 2½ in. Each pair of boilers and each set of engines are in separate compartments.

The armament is of the best and newest type. The guns are two 4.7-in. of Armstrong's make, the four 8-pounder and two 3-pounders being Maxim-Nordenfeldt, carried on the spar deck, and two 1-in. machine guns on the bridge, whilst the torpedo equipment consists of one bow tube and four broadside tubes carried on the main deck, worked through specially designed ports, the torpedoes being made by Whitehead, of Fiume, of the latest 18-in. pattern. The completion of every detail of arrangement for the efficient and convenient working of this small but powerful cruiser reflects great credit on the builders, who designed all the details of the vessel and machinery, and adds another success to their well-earned and leading position as naval ship constructors.

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AMERICAN.

AMERICAN ENGINEER AND RAILROAD JOURNAL.

VOLUME LXVIII., No. 9, SEPTEMBER, 1894. The Pneumatic Dynamite Guns (illustrated). Mr. Maxim's Flying Machine. The Brown Traveling Crane. The Influence of Circulation on Evaporative Efficiency of Water-Tube Boilers. Centrifugal Pumps. Pole and Rope Construction Staging. The Auxiliary Machinery of a Modern Cruiser. Mosher Water-Tube Boiler.

No. 10, OCTOBER. United States Cruiser Cincinnati. Methods of Determining Copper and Lead in Phosphor Bronze. Quadruple-Expansion Engine for Third-Class Torpedo-Boat. Brown's High Speed Engine. Centrifugal Pumps (continued). The Heating Power of Smoke, by R. R. Tatlock, in the Chemical News.

From the results of these experiments it is evident that the loss of combustible matters in smoke is very small indeed, and that the belief in immense loss by this cause is simply a fallacy, and is decidedly not corroborated by experiment. In adopting methods of removing the smoke nuisance it must therefore be borne in mind that there is little or no gain in burning smoke, and that other methods of dealing with the problem, such as Dulier's Smoke Absorption process, ought also to receive consideration.

A War Balloon Struck by Lightning. Navigable Balloon at the Antwerp Exhibition. The Development of Aerial Navigation, by Hiram S. Maxim.

No. 11, NOVEMBER. Centrifugal Pumps (continued). Engine Cylinder Clearances and Initial Condensation. The New Russian Armored Ship Admiral Seniavin. Chinese Railroads. The Enigmas of the Elements.

No. 12, DECEMBER. The United States Triple Screw Cruisers Columbia and Minneapolis. Water-Tube Boilers and their Application to War Vessels. The Bow Fire of Modern Ships. Why is Artificial Flight so Difficult of Invention?

BULLETIN OF THE AMERICAN GEOGRAPHICAL SOCIETY.

VOLUME XXVI., No. 3, SEPTEMBER 30, 1894. The American Cave Dwellers; the Tarahumaris of the Sierra Madre. Fur Seals and

the Behring Sea Arbitration. Geographical Notes. Washington Letter. Map of the Siberian Railway.

CASSIER'S MAGAZINE.

VOLUME VI., No. 35, SEPTEMBER, 1894. Modern Light House Service. The Auxiliary Machinery of an Ocean Greyhound. Practical Flight. Corrosion of Steam Drums. Aeronautic Engineering Materials, by R. H. Thurston.

The whole matter may be summed up in the statement that steel, in its various known grades and qualities, is to-day the one unrivaled substance for all constructions.

Replacing a Damaged Engine Foundation.

No. 36, OCTOBER. Silver Mining in South America. The Evolution of the Modern Steam Engine. Proper Connection of Boilers and Engines. Incandescent *vs.* Arc Lighting. Reminiscences of By-Gone Electrical Days. Speculations on Cylinder Condensation. A Note on Compressed Air. How Materials are Tested.

ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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NOVEMBER 1. The Pneumatic Dynamite Gun on the Brazilian Cruiser Nictheroy.

NOVEMBER 15. The Effect of Stress on the Corrosion of Metals.

NOVEMBER 22. The Present Status of Face Hardened Armor, by Captain W. T. Sampson, U. S. N. (paper read at the recent meeting of the Society of Naval Architects and Marine Engineers). Hydraulic Power for Warships. Torpedo Launch for the U. S. Battleship Maine.

IRON AGE.

VOLUME LIV., No. 10, SEPTEMBER 6, 1894. Forging by Hydraulic Pressure.

SEPTEMBER 13. Trials of Dynamite.

SEPTEMBER 20. Most Economical Temperature for Steam Engine Cylinders. Dupont Powder Company's Proving Ground. Vessels on the Great Lakes. Steam Power of the World.

SEPTEMBER 27. The Inspection of War Material.

OCTOBER 4. The New Hurst Gun. Casting Aluminum Bronze. New Torpedo-Boats.

OCTOBER 18. The Casting Temperature of Soft Steel (continued in next issue). An Aluminum Torpedo-Boat.

OCTOBER 25. Steel Boiler Tubes and their Tests. Fuel for the Navy.

The cost of fuel for the ships of the United States Navy is set forth in the annual report of the Chief of the Naval Bureau of Equipment as having been $191,291 last year in excess of the year preceding, on account of the increased activity of the navy, due to the Brazilian, Salvadorian, Mosquito Coast and Hawaiian troubles. During the past year there were purchased at home 42,190 tons of coal, costing $178,163, of which quantity 9505 tons were purchased on the Pacific Coast at an average cost of $7 per ton, and 32,685 tons on the Atlantic Coast at an average cost of $3.33 per ton. There was expended abroad, $462,192 for 52,146 tons of coal, an average cost per ton of $8.86. Of a total of 56,722 tons of coal used by the new ships of the navy during the year, 40,521 tons, or 71 per cent., were for steaming purposes, and 16,201 tons, or 29 per cent. were for auxiliary purposes, including electric lighting, distilling, heating, flushing, cooking, ventilation and steam cutter service.

NOVEMBER 1. The Morgan 1000-Ton Forging Press. The Okhta Armor Plate Trials. A New Gaseous Constituent of our Atmosphere.

NOVEMBER 8. A Fifteenth Century Gun—Mons Meg (illustrated). Hydraulic Boiler Plate Bending Machine. The Howell Torpedoes.

NOVEMBER 15. The Proposed U. S. Torpedo-Boats. Open Hearth Steel, I. The Pitting of Boilers.

NOVEMBER 22. Hydraulic Steering Gear on the U. S. S. Olympia. Merchant Marine and the Navy.

NOVEMBER 29. Open Hearth Steel, II. A New Small-Arm.

DECEMBER 6. A Substitute for Rifling Guns. The Present Status of Face Hardened Armor, by Captain W. T. Sampson, U. S. Navy (a paper read before the Society of Naval Architects and Marine Engineers). Notes on Steel Forgings, by George M. Sinclair (American Society of Mechanical Engineers).

"For steel, the product of the hammer is equal, if not superior, in quality to that of the press. There is, however, a chance for bad practice in the use of hammers which does not exist with presses. . . . For high class work, the temperatures of the furnace, composition of the metal and physical tests must be noted. In fact, no one at this time can hope to compete for high grade work without the free use of the chemical laboratory and testing machine, and making and preserving more or less elaborate records.

"Oil tempering opens the way for a bad practice, which is not always avoided as it should be, and, in fact, is not always recognized as such. We refer to the selection of a very soft steel for the forging, and tempering up to fill specifications. This is sometimes carried to such an extent that the final annealing is so slight as to be a farce. While oil tempering benefits the metal it leaves it with considerable internal stress, which should be relieved by an effective annealing. At the outset, therefore, a sufficiently high grade of steel should be selected to permit of thorough final annealing."

JOURNAL OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

NOVEMBER, 1894. The Modern Marine Engine, Boilers, etc. Contract Trial of the Minneapolis. Welded Steel Steam Pipes. Suction Draught for Boilers. Air Pumps. Electric Welding.

JOURNAL OF THE FRANKLIN INSTITUTE.

SEPTEMBER, 1894. The Graphics of the Efficiencies of the Steam Boiler, by R. H. Thurston. Engineering Practice and Education (continued in succeeding issues).

OCTOBER. The Centrifugal Pumping Plant at Mare Island Navy Yard, California.

NOVEMBER. A Practical and Easy Method for Determining or Comparing the Freeboard.

DECEMBER. The Law of Invention.

JOURNAL OF THE MILITARY SERVICE INSTITUTION.

VOLUME XV., No. 71, SEPTEMBER, 1894. The National Guard. The Care of the Wounded in Time of War. The Military Value of the Donkey. Intrenched Camps. War Ships or Coast Defenses. Staff Service in the State Troops. Military Railway Transportation. Comment and Criticism, etc.

NOVEMBER. A Paper on Military Libraries. The New Small Caliber Rifle. The Multiplication of Calibers. Book-keeping for Post Exchanges. Non-existence of Martial Law Proper. The Military Service of Indians. The Proposed Deep Water-Way. The Mexican Army. Comment and Criticism, etc.

JOURNAL OF THE UNITED STATES ARTILLERY.

VOLUME III., No. 4, WHOLE No. 13, OCTOBER, 1894. Some Tests of the Magnetic Qualities of Gun-Steel. Practical Suggestions Concerning the Armament for Sea-Coast Fortifications. Range Table for the 5-inch B. L. Rifle. The Artillery of the U. S. National Guard. Coast Artillery Fire Instruction. The Artillery of the Future.

OFFICE OF NAVAL INTELLIGENCE, GENERAL INFORMATION SERIES. NOTES ON THE YEAR'S NAVAL PROGRESS.

No. 13, JULY, 1894. Introduction. Notes on Naval Administration. Notes on Ships and Torpedo-Boats. Notes on Ordnance. Notes on Small-Arms. Notes on Naval Dynamo Machinery. Marine Boilers. Conclusions and Recommendations of the Committee Appointed to Consider Existing Types and Designs of

Propelling Machinery and Boilers in H. M. Ships. The Qualities and Performances of Recent First-Class Battleships. Some Naval Manœuvres in 1893. The Revolt in Brazil. Some Standard Books on Professional Subjects. Index.

PROCEEDINGS OF THE AMERICAN ACADEMY OF ARTS AND SCIENCES.

VOLUME XXIX., 1894. On Chronic Arsenical Poisoning from Wall Papers and Fabrics. Further Observations upon the Occurrence of Diamonds in Meteorites. On an Apparatus for the Measurement of Coefficients of Self-Induction and the Investigation of the Phenomena of Alternating Currents. On the Group of Automorphic Linear Transformations of a Bilinear Form.

SCIENTIFIC AMERICAN.

OCTOBER 13, 1894. New Signaling Apparatus.

It consists of a collapsible canvas sphere constructed with ribs somewhat like an umbrella, and is made to open and close by means of movable collars attached to the mast. The collars are connected with rods which pass through the interior of the mast to the lower deck, and are actuated by levers worked within the protection of the side armor in battleships or beneath the protective decks of cruisers.

The Japanese Victory.

OCTOBER 20. A Bullet Proof Shield. The United States Ram Katahdin. A Day on the Fish Hawk.

OCTOBER 27. Visibility of Torpedo-Boats. Trial of the Battleship Maine. An Aluminum Torpedo-Boat.

NOVEMBER 3. The Magazine Rifles of Europe. How to Deal with Apparent Death from Electric Shock.

NOVEMBER 10. Small Caliber Projectiles. The Submarine Detector. Aluminum not Suitable for Boats.

On account of its comparatively light weight, its utility on board ship would be almost inestimable if it were not for the fact that it has been now shown to be exceedingly susceptible to the corrosive action of salt water.

Two sheets, one-sixteenth of an inch thick, were immersed for three months at the Norfolk Navy Yard. One was of pure metal, and the other slightly alloyed with nickel. The pure plate was thickly covered with large barnacles throughout its surface, and was more or less pitted by the action of salt water. The alloyed plate was incrusted with smaller barnacles and was badly corroded, being perforated and eaten away over much of its exposed surface. This plate was as injuriously affected as a combination of iron and copper would have been with the same exposure.

The claim that barnacles would not adhere to the metal was not substantiated in the smallest degree.

Sunken Vessels Raised by Air-Bags.

NOVEMBER 17. The Torpedo.

NOVEMBER 24. American Search Lights in the East.

An officer of the Japanese Navy has written a letter to a friend in this country, in which he speaks highly of the efficiency of several American electric search lights used in the fleet to which he is attached. These lights stood the test of actual service better than the English and German apparatus, which will be doubtless condemned by a board of survey. He also states that the best maps of the Yellow Sea and Corea are from the United States Hydrographic Office in Washington. These maps and charts are compiled from the latest data, and the principal roads in Corea are clearly indicated.

Magnetic Properties of Asbestos.

DECEMBER 1. Rolled Weldless Chains. An Improved Litter.

THE UNITED SERVICE.

SEPTEMBER, 1894. A Lesson from the Chicago, by Nauticus.

OCTOBER. A Personal Narrative of the Wreck of the Vandalia at Samoa, March 16, 1889. Origin and Developments of Steam Navigation (continued in succeeding issues).

NOVEMBER. The Magazine Rifle.

DECEMBER. Interior Water-Ways, from New York to the Gulf Coast.

J. H. G.

FOREIGN.

ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

XXII., ANNUAL SERIES, 1894, VOLUME IV. The Hydrography of the Straits of Formosa in its Relation to Practical Navigation. Drift Ice in Southern Latitudes. Route from Cape Horn to the Line. Dust Fall in the North Atlantic.

Reports of the fall of dust at sea experienced by vessels in making passages in the North Atlantic.

To the Study of the Use of Oils at Sea. The Great Storm of 7–12 February, in Russia. The North Atlantic Storm of 22–26 March. Notes for the Sailing Directions "West India Pilot," Vols. I and II. Voyage from Nagasaki to Kobe. From Santos to Rangoon. Guantanamo, Cuba. Notes on Supplies Stored on Uninhabited Islands in the South Sea for the Use of Shipwrecked Sailors. On a Voyage from Macassar to Basseni. On Currents in the Southern Portion of the China Sea. Shoals on the Coast of St. Catharine Island, Brazil.

Meteorological Journals received at the German Naval Observatory in March, 1894.

Weather Reports for March, 1894, for the Coast of Germany.

VOLUME VI. Prince Henry, the Seaman. On the Range of the Barometer between the Winter of 1883–'84, and the Fall of 1887. A new Method of Deducing the Harmonious Constants of Tides. The Use of Soap-Water at Sea. The Glittering of Stars in its Relation to the Weather. Notes on the Remarkable Drift of two Bottles in the Equatorial Zone of the Atlantic Ocean. Marine Signals on the East Coast of Africa.

Meteorological Journals received at the German Observatory in May, 1894.

Weather Report for May, 1894, for the German Coast.

VOLUME VII. A Double Refractometer to Determine the Specific Gravity of Seawater. To the Study of Calming the Waves. A New Method of Deducing the Harmonious Constants of Tides (continuation). Precautions in Loading with Coal. Hydrographic Notes on Rio Grande da Sul. Notes on Iwo-Sima and Hesper Islands; Lu-Tshu Islands.

Meteorological Journals received at the German Observatory during June, 1894.

Weather Report for June, 1894, Coast of Germany. Sixteenth Annual Report of the German Naval Observatory.

VOLUME VIII. Report on the Seventeenth Competitive Tests of Chronometers made by the German Observatory in the Winter of 1893–'94. The State of Ice on the Russian Coast in the Years from 1888 to 1893. A New Method of Deducing the Harmonious Constants of Tides (conclusion). Voyage from Nagasaki to Shanghai. Notes on the Resistance of Air; on the Height of Sea-breezes; on a Remarkable Illumination at Sea.

Meteorological Journals received at the German Observatory during July, 1894.

Weather Report for July, 1894, for the Coast of Germany.

VOLUME IX. Description of Russian Mercantile Ports. Anchorages in Norway. The Gulf Stream. Photographic Surveys of Coasts. Voyage from Shanghai to Hankow. Voyage from Singapore to Colombo, to the Seychelles Islands, to Zanzibar, and to Capetown. Voyage from Montevideo to Punta Arenas, and Valparaiso. Report on Sea-quakes. Remarks on the Approach to Beira, East Coast of Africa. Notes on Land-birds at Sea; on the Low Barometer during the Storm of January 9, 1894, on the North Atlantic.

Meteorological Journals received at the German Observatory in August, 1894.

Weather Report for August, 1894, for the coast of Germany.

VOLUME X. The Physical Geography of the Ocean. On the Hydrography and Meteorology of the German Post-Route between

Singapore and Herberts-höh (New Pomerania). Voyages through the Red Sea, and on the East Coast of Africa. Voyage from Rio Janeiro to Valparaiso. Loando and Kameroon. Cartagena, Columbia. Notes on the Use of Oil at Sea; Pilot Service at Savannah, Georgia; Depot of Stores for Shipwrecked Sailors on the Kerguelen, St. Paul, and New Amsterdam Islands; Report on the Use of Soapwater at Sea; Currents between Apia and Sydney; Loss of the S. E. Trades between Sydney and Apia in May, 1894.

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Weather Report for September, 1894, for the Coast of Germany. H. O.

ARMY, NAVY AND DEFENSE REVIEW.

VOLUME I, No. 10, AUGUST 31, 1894. Naval Fleets in Corean Waters. J. H. G.

BOLETÍN DEL CENTRO NAVAL.

JUNE AND JULY, 1894. Plan of a Practice Cruiser. The First Chapter of the Organic Regulations of the Naval School. The Incandescent Lamp.

AUGUST AND SEPTEMBER. Reorganization of the Staff Corps of the Navy (Argentine Republic). Reorganization of the Italian Naval Academy. Preliminary Notes for the Text of the Universal and Particular Maritime Geography of the Argentine Republic. J. L.

DEUTSCHE HEERES-ZEITUNG.

JULY 25, 1894. A New Formation for Attack. Contributions to the History of the War in Germany in 1744–'45 (continued).

AUGUST 1. Infantry Attack. Contributions, etc. (continued).

August 4. The Russian Artillery. Contributions, etc. (continued).

AUGUST 8. German Infantry. Contributions, etc. (continued).

AUGUST 11. The Naval Battle in the Yellow Sea.

A brief account of the battle between the Japanese fleet and a Chinese convoy, which occurred on July 27, and in which the Kowsing was sunk. The writer condemns the Chinese commander for leaving the weaker vessels to their fate and not interposing the entire strength of his squadron to protect the convoy. He also criticises the action of the Viceroy in telegraphing to the Chinese representatives in Europe to procure ships and munitions of war at any price.

Contributions, etc. (continued).

AUGUST 18. The Use of Cavalry for Reconnoissance and Patrol Service. Contributions, etc. (concluded).

AUGUST 22. A French Plea for Reserve Officers.

AUGUST 25. The Equipment of the German Cavalry. The Use of the Field Artillery.

AUGUST 29. The Fortifications of Nancy. The Use of Field Artillery (concluded).

SEPTEMBER 1. The Italian War College.

Recent order changing the organization of this institution, both as regards administration and course of study. Also regulations prescribing the mode of detail of officers for instruction and examination.

SEPTEMBER 5. English Torpedo-Boat Destroyers.

A review of the development of the torpedo service of the English Navy in recent years.

Contribution to the History of the Defense of the Cemetery at Beaune la Rolande.

SEPTEMBER 8, 12, 15, 19. Regulations for Service in the Field in 1894 in Germany. Contribution to the History, etc. (continued).

SEPTEMBER 22. General v. Cranach, of the German Army. Contribution to the History, etc. (continued).

SEPTEMBER 26. The Rifle of the Future. Contributions to the History, etc. (continued).

SEPTEMBER 29. The Naval Battle near Hai-Yang-Tan.*

According to the writer, this decisive battle, which took place on September 17th, near the eastern mouth of the Yalu river, demonstrated the superiority, both of men and material, of the Japanese Navy, and also that the Japanese admiral is not such a naval commander as every naval power possesses. The Japanese fleet only destroyed several Chinese ships, when it should have destroyed the entire fleet, and it permitted the Chinese admiral to carry out his purpose to safely convey transports of troops to their destination. Finally, the worst feature of his action is that he did not pursue the Chinese squadron but allowed it to escape in its crippled condition. Admiral Ting, fully recognizing the superiority of the Japanese in ships and rapid-firing guns, as well as in the efficiency of their crews, sought to avoid a battle, notwithstanding urgent orders from Peking. He received orders from Tien-tsin, to convoy a fleet of transports loaded with troops and war material, to the mouth of the Yalu, where it was intended to establish a base for operations in Corea.

Apparently Admiral Ting carried out his purpose, if the transports on the day of the battle succeeded in discharging their cargoes. On this point further information will be necessary, but it is certain that, by the admiral's course, the transports reached their destination and had about ten hours to land troops and material. The Chinese attained their object,

*Battle of the Yalu. The criticism is a little wild, and some of the statements do not agree with the facts. For example, the great loss on the Matsushima is said to have been caused by one of the Chen-yuen's 30.5-cm. guns, while the writer says not one of the heavy Chinese guns is said to have hit. It is, moreover, well known that the Chinese were not at anchor.

the landing of their troops and material; while, on the contrary, the Japanese did not accomplish theirs, the destruction of the Chinese fleet and convoy.

Why they discontinued the battle, and did not energetically endeavor to attain one of these objects, is entirely incomprehensible. A more serious injury to their fleet, than has been acknowledged, may explain it.

The battle was fought about as follows: At noon of September 17, the Japanese fleet was sighted, approaching in double column. The Chinese transports ran into the Yalu, and the Chinese fleet formed in double line at close distance to protect the entrance to the river. This plan of battle was forced upon Admiral Ting, for he could not stand off and meet his opponent, lest he expose the transports to attack and destruction before they could accomplish their object. He was, therefore, at a disadvantage from the beginning, for his ships could not manœuvre, and could not make use of their rams. It is probable that the Chinese fleet was at anchor, and remained so during the battle. Had the fleet been under way there would have been sufficient room to have enabled the fast Japanese ships to steam around it and enter the river and destroy the transports. That this was not done, is another evidence that the Chinese were at anchor. They remained from noon until dark in the same position. At noon the battle began; by this time the transports must have already reached the Yalu, otherwise they would have fallen into the hands of the Japanese.

The battle was fought principally with the guns, though as nearly all vessels carried torpedoes, it is to be assumed that a number were launched. If only one of these was successful, it proves once more how unreliable they are as naval weapons. At dusk the Japanese, after unsuccessfully attempting to break through the Chinese lines, withdrew. The Chinese losses were King-Yuen, sunk by the guns; Tsing Yuen, sunk by a torpedo; Tsao Yung, ran aground and was burnt, and the same fate happened to her sister ship, the Yang-Wei. All the other vessels were more or less injured, especially the Chen Yuen, but she could not be sunk by artillery, a result to be noticed. The Chinese loss in men is reported as 1500, but that is about one-half of the total complement of their ships, and seems exaggerated.

The Japanese, according to their reports, did not lose a vessel, although the Chinese officers reported having seen three or four Japanese vessels go down. Yet, as they could not give the names, there is probably little truth in the report.

The Japanese report having lost 180 men.

The reasons are asked: If the loss of the Japanese was so small, why did they not continue the battle by electric light, with which every vessel was provided, until they had destroyed the entire fleet? Further, with such slight injury, why did they withdraw during the night? Still further, one of the elementary rules of war, which applies at sea as well as on land, is that the victor must keep in touch with his opponent. This rule seems to have been entirely ignored by the Japanese admiral. No European admiral, with a fleet intact, would have allowed the Chinese fleet to remain unobserved during the night, especially when he had nothing to fear from that fleet.

The Japanese, in steaming away, seem to have entirely forgotten their principal object, the destruction of the transports. The only solution to the question, "Why did they give up the fight?" is that they also suffered severely in the battle.

A part of the Chinese ships are said to have exhausted their ammunition, and of all their heavy guns not one is said to have made a hit in a battle of seven hours' duration.

What became of the troops, material and the transports, the destruction of which was the principal object of the battle, is not known. It is not to be assumed that at night the Chinese fleet steamed away without the transports—for they could have done that at noon and avoided the battle. Besides, there was no object in leaving them after the Japanese had withdrawn. It is, therefore, possible that they landed everything, and that the whole object of the expedition was attained with the loss of four ships.

How it will fare with these troops, cut off from their base by sea, is another question. Surely, theirs is not an enviable situation.

There is still the case that the transports had not completed the discharge of their cargoes, when the Chinese withdrew, to be considered. Should this prove the case, Admiral Ting is open to the severe reproach of having deserted these ships without any reason. He should, at least, have protected them with those of his vessels least injured, until the transports had been discharged. But these had ample time to accomplish their purpose, for no Japanese vessel disturbed them. Should this prove true, then, the Japanese will understand the enormity of their mistake, for had they observed the movements of their opponent during the night, they would have known of his departure, and on the morning of the 18th could have run into the Yalu and captured or destroyed every transport.

Finally, there is yet one more possibility at hand—in the East everything is possible, viz.: the fleet of transports may have landed no troops, or the troops without the supplies, or only a part of each; and at night may have joined the protecting fleet and steamed away with it. If this happened, the whole expedition was as aimless as the battle.

There is little to be learned from this battle, for both sides have such strong peculiarities. It would be desirable to have the news, favorable or otherwise, a little less exaggerated.

Since the battle of Hai Yang-Tan, Japan, which had the greater part of her best ships engaged, has control of the sea, but the Chinese fleet is by no means destroyed.

Contributions to the History of the Defense of the Cemetery at Beaune la Rolande (continued).

OCTOBER 3. The French Autumn Manœuvres. Contribution to the History of the Defense of the Cemetery at Beaune la Rolande (continued).

OCTOBER 6. The Recent Occurrence at the Chief Gunnery School in Berlin. Contributions to the History of the Defense of the Cemetery at Beaune la Rolande (concluded).

OCTOBER 10. The Russian Navy. The Battles of Ladon and Maizieres on November 24, 1870.

OCTOBER 13. A Criticism of the French Manœuvres. The Battles, etc. (continued).

OCTOBER 17. Infantry Fire. The Battles, etc. (continued).

No. 84, OCTOBER 20. English, German and French Naval Material in China and Japan.

A review of the material built for China and Japan, by the above named countries, and a criticism of the merits of each as developed in the naval

engagement off the Yalu river, September 17. The discussion is a refutation of the claim of superiority for the French material.

The Battles, etc. (continued).

OCTOBER 24. Military Espionage. The Battles, etc. (continued).

OCTOBER 27. The Battles, etc. (continued).

OCTOBER 31. On the Frontier. The Battles, etc. (continued).

NOVEMBER 3. Strategy of the Future. The Battles, etc. (continued).

NOVEMBER 7. Emperor Alexander III. The Battles (continued).

NOVEMBER 14. The French Grand Manœuvres. Modern Reserves.

NOVEMBER 17. The Question of Non-Commissioned Officers in France. Modern Reserves (continued). H. O.

ENGINEER.

VOLUME LXXVIII., No. 2018, SEPTEMBER 7, 1894. The Torpedo-Boat Destroyers Ferret and Lynx. The Chilian Cruiser Blanco Encalada (illustrated). Methods of Determining the Dryness of Steam.

SEPTEMBER 14. The Decennial Programme for Naval Construction in France. The Argentine Cruiser Patria. Rustless Coatings for Iron and Steel. Rankine's Marine Filter.

SEPTEMBER 21. Antwerp International Exhibition, Maritime Section, II. Rustless Coating for Iron and Steel (continued). Vibration of Steamships. Primary Batteries (Electric) for Launch Work.

SEPTEMBER 28. Hydraulic Capstans.

OCTOBER 5. An Aluminum Torpedo-Boat. Chinese Warships at the Battle of Yalu. Lord Armstrong on Ships and Guns. Spratt's Electrical Speed and Direction Indicator. Artillery Fire in the Chinese War. Rustless Coatings for Iron and Steel (continued).

OCTOBER 12. The French Cruisers Alger and Isly. Progress of Bessemer Steel. The Uncertainties of Science. On the Heating Power of Smoke.

OCTOBER 26. A Modern Naval Battle. Rolled Weldless Chains.

NOVEMBER 16. Japanese War Vessels.

NOVEMBER 23. Penetration and Action of Small-Arm Bullets. Canet Guns at Yalu. New Galvanic Element.

ENGINEERING.

VOLUME LVIII., No. 1497, SEPTEMBER 7, 1894. The Guns and their Mountings of the Spanish Belted Cruisers.

SEPTEMBER 14. The United States Infantry Magazine Rifle. The Work and the Cost of the Navy.

SEPTEMBER 21. H. M. Torpedo-Boat Destroyer Ferret. The Corrosion of Tail Shafts in Steamers. On a Rapid Method of Calculating Wetted Surfaces.

The following formula was eventually chosen to give closely accurate results for medium draughts, beams, and finenesses:

$$S = (L \times D \times 1.7) + (L \times B \times C),$$

where

S = wetted surface in square feet.
L = length between perpendiculars in feet.
D = middle draught in feet.
B = beam in feet.
C = block coefficient.

It might also be written—

$$S = L \{ (D \times 1.7) + (B \times C) \}.$$

SEPTEMBER 28. The West Point Soldiers' Monument. Machinery of the Twin Screw Torpedo Gunboat Hazard. The Naval Battle. The Friction Clutch in Theory and Action.

OCTOBER 5. Aluminum in Torpedo-Boat Construction. A 7-in. Breech Loading United States Siege Mortar.

OCTOBER 12. Some Remarks on Modern Naval Tactics. Hydraulic Boiler Shell Plate Bender.

OCTOBER 19. Some Remarks, etc. (continued).

OCTOBER 26. Some Remarks, etc. (continued).

NOVEMBER 2. Triple-Expansion Engines of H. M. Torpedo-Boat Destroyer Daring. Some Remarks, etc. (concluded).

NOVEMBER 9. Armor Plates and Projectiles. Wind Pressure.

NOVEMBER 16. The Training of Marine Engineers. H. M. S. Ardent.

NOVEMBER 23. 12½-in. Equatorial Telescope for Rio Janeiro. Naval Defense Act. List of Vessels. Particulars of Trials. The Early History of Crucible Steel.

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

VOLUME XXXVIII., No. 199, SEPTEMBER 15, 1894. The Training of Volunteer Officers. National Methods of Obtaining a Supply of Seamen. Le Soudan Français, and Recent French Operations on

the Upper Niger. School Sword Play. Researches on Modern Explosives.

OCTOBER 15. Some Methods of Executing Infantry Fire on the Battlefield. Signaling: Present Defects and Suggested Improvements. Recent Progress in Marine Machinery. Lobell's Annual Reports on the Changes and Progress in Military Matters during 1893. J. H. G.

LE MONITEUR DE LA FLOTTE.

SEPTEMBER 8. Safety at Sea.

"Commander Riondel continues with vigorous and commendable zeal his humane campaign in favor of sea lanes, in order to diminish the constant dangers to which fishing crafts are exposed on the Banks of Newfoundland, and laments the absence of an international law imposing penalties upon captains guilty of the violation of Article 13 of the International Maritime Conference."

SEPTEMBER 15. The Italian Naval Academy. The Mishap to the Torpedo-Boat 120.

SEPTEMBER 22. The Italian Naval Academy (concluded). The Lengthening of Ships.

SEPTEMBER 29. River Gunboats for Colonial Expeditions.

OCTOBER 6. The Guns on Board our Warships.

OCTOBER 13. Safety at Sea once more.

OCTOBER 20–27. The Superintendency of Navy Yards.

NOVEMBER 3. A Submarine Gun. The Accident on Board the Aréthuse.

NOVEMBER 10. Seagoing Torpedo-Boats.

NOVEMBER 17. The Madagascar Expedition.

"Aluminum barges of light draft will be used in conveying troops up the Betsiboka river.

NOVEMBER 24. An Inquiry touching the Seagoing Torpedo-Boats. J. L.

MINUTES OF PROCEEDINGS OF THE INSTITUTION OF CIVIL ENGINEERS; WITH OTHER SELECTED AND ABSTRACTED PAPERS.

VOLUME CXVIII., 1894. The Training of Rivers, illustrated by the Results of various Training-Works. Estuaries. The Manufacture of Briquette Fuel. Recent Types of Ferry-Steamers. The Relation of Mathematics to Engineering. The Effect of Stress on the Corrosion of Metals. Railway Work in Argentina. On Forms

of Tensile Test Pieces. Refrigerating Machines. Ship Slip-Ways: the Dover Slipway. Discussions. Experiments on Wind Pressure.

J. H. G.

MITHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOLUME XXII, No. 8. The Geographical Researches of the Scientific Expeditions of the German Ships in 1892 and 1893. Naval Events during the Revolution in Brazil in 1893–'94.

(A review of the active naval operations during the revolution).

The Russian Battleship Ssyssoi Veliki.

This vessel was launched on the 20th July last. The hull is built of steel on the cellular system, with double bottom extending the entire length. By transverse and longitudinal bulkheads it is divided into 217 compartments. Extreme length, 107.2 m.; extreme breadth, 20.73 m.; displacement, 8800 tons; draught, aft, 7 m.; forward, 6.7 m. Her protective deck is 76 mm. thick, and slopes from 0.9 m. above the water-line amidships to 1.5 m. below at the sides. Armor on turrets and casemate is 40.6 cm. thick. Her armament consists of four 30.5-cm., 40 cal. Oboukhov rifles, mounted in pairs in turrets, forward and aft; six 15-cm. rifles mounted in the casemate, and 18 rapid-fire guns, four of which are mounted in the casemate, and the remainder on the upper deck, bridge, and military masts. She has six torpedo-tubes for Whitehead torpedoes, and is provided with two torpedo-boats, with mines, torpedo-nets. and electric search-lights. She is lighted by electricity.

She has two triple-expansion engines, in separate compartments, and twelve Belleville boilers in three compartments; her machinery, developing 8600 H. P. giving a speed of 16 knots.

She carries 550 tons of coal in her bunkers, which, at a speed of 10 knots, gives her a radius of 5000 knots.

Her total cost will be 8.5 millions rubles. She is the fourth ship of this name in the Russian Navy.

The Trial of the French Battleship Magenta. Canet's Central Pivot Mount for Rapid-Firing Guns. The French Battleship Jaureguiberry. The French High-Sea Torpedo-Boats, Tourmente and L'Argonaute. Accident on Board the Submarine Boat Gustave Zédé. The French Cruisers Isly and Jean Bart. The French Torpedo Cruiser Cassini. The Acceptance Trial of the Chilian Cruiser Blanco Encalada. The Spanish Fleet Manœuvres of 1893. The American Torpedo-Boat Ericsson. The Italian Naval Budget for 1894–'95. Naval Appropriations for 1894–'95, Comparative Tests of Armor Plates at Pola in 1893.

The results of these tests, and a comparison with those held in other countries in recent years, show that the Witkowitzer plate gave better results than any other.

Tunnard's and Keay's Automatic Electric Fire Alarm.

No. 9. Water-Tubular Boilers and their Adaptability to War Vessels. The Acceptance Test of a 27-mm. Witkowitz Nickel-

Steel Plate. The Stability of Recent English Battleships. Speed Trials of the English Torpedo-Boat Destroyer Daring, and of the Torpedo-Boats, 1st Class, Nos. 91 and 93. The English Battleships Majestic and Magnificent. Recent English Cruisers of the Second Class. The English Torpedo-Boat Sharpshooter. The Effect of Bilge Keels on the Rolling of Ships. A New Method of Protection against Torpedo-Boat Attack. The Speed Trials of the German Battleship Wörth. The French Naval Budget for 1895. Fire at the Navy-Yard, Toulon. The Trial of the Machinery of the Italian Cruiser Umbria. The Italian Torpedo Gunboat Caprera. The Twin-Screw Steamer St. Petersburg of the Russian Auxiliary Fleet. Russia's Aum-Daija Fleet.

This fleet will be reconstructed as transports, and will be strengthened by vessels from a private company.

The Establishment of a Dockyard at Sebastopol.

Owing to the insufficiency of the dockyard at Nikolaieff, the Russian government is establishing a dockyard at Sebastopol. This is so far advanced that, in the course of the year, two heavy armored vessels and three cruisers will be laid down for service in the Black Sea. At present, the naval force in this sea is undergoing a complete reorganization. In the future, the Governor-General of Sebastopol will be charged with the chief command of the coast defense. This office, heretofore held by an army officer of high rank, will in the future be occupied by a naval officer, under the title "Commander-in-chief of the Black Sea Fleet."

Launch of Torpedo-Boats in Norway.

On May 17, 1894, two torpedo-boats, the Varg and Raket, were launched at Christiania for the Norwegian Navy. They are sister ships, have a length of 34 m., breadth 3.7 m. and are of 43 tons displacement. They have triple-expansion engines; one has a Thorneycroft boiler, while the other has a du Temple boiler. The former was constructed in Norway, while the latter was built in France. Each has two under-water torpedo the tubes, one at bow and the other on the beam.

The Speed-Trial of the Minneapolis. Trial of the Turrets of the Monterey. New Japanese Battleships. Test of a Harvey Armorplate at Indian Head. The Leonard Smokeless Powder. The Jackson-Harmsworth Polar Expedition. New Projectors with Parabolic Mirrors.

No. 10. Progress in Photographic Measurements. Water-Tubular Boilers and their Adaptability on Board Warships. Speed-Trials of the Italian Battleship Sardegna.

At a recent trial of this vessel, the attempt to run at full speed under forced draught had to be abandoned after two hours, because the high air pressure, 25 mm., and the great heat in the boiler-rooms prevented the firemen from serving the boilers efficiently. The steam pressure could not be retained. A trial was then made with the natural draught, open fire-rooms, and slow-running ventilators, with the most satisfactory results, which were very slightly less than those obtained under forced draught.

With forced draught the engines developed 16,220 H. P., and the mean H. P. for the two hours was 15,000 H. P. The highest speed obtained was 20.2, and the mean speed 19.64 knots per hour. Although the results obtained were less than those anticipated from the preliminary trials, still they were very satisfactory, and gave the assurance that with forced draught the contract requirements could be obtained. It was, therefore, deemed advisable not to subject the boilers to the strain of another trial under forced draught. With the exception of the unfavorable condition of the boiler-rooms during the forced draught trial, all parts of machinery worked most satisfactorily.

Trial of the 12-cm. Bafor's Rapid-Fire Gun mounted on an Armored Carriage. The Cruiser Olympia. The Trial of the Minneapolis. The English Navy.

The trials of the torpedo-boat destroyer Ferret, and of the cruisers Charybdis, Flora, and Crescent. The Launch of the Eclipse.

On the Speed of English Torpedo-boat Destroyers. Accepted Trial of the English Torpedo-Boat Destroyer Daring. The Launch of the French Armored Cruiser Bruix. The French High Sea Torpedo-Boat Lé Chevalier. The Russian Navy. Inspection Tour of the Italian Minister of Marine. The Effect of the Torpedo Attack on the Aquidaban. Regulations for the Use of Steam Power and Forced Drafts Adopted in the German Navy. Test of a Carnegie Armor Plate. The Conversion of Sea into Potable Water.

A description of the invention of Engineer Pfister for the conversion of sea-water into potable water without distillation.

No. 11. Ice Machines on Board Ship. Essay on the Best Tactics to Develop the Efficiency of Ships and their Armaments (Gun, Ram and Torpedoes) in a Battle between Fleets, Groups, and Single Vessels. The Bow Torpedo Tubes of Torpedo-Boats. The Machinery of the English Torpedo-Boat Destroyers Daring and Decoy. The Salvage of the Sunken Italian Torpedo-Boat 69 S. The Accident to the Italian High Sea Torpedo-Boat Avvoltoio. Speed Trials of the French Torpedo Despatch Boat D'Iberville. Boiler Explosion on the French Torpedo-Boat No. 120. Normand's Feed Water Heater for Torpedo-Boats. The English Navy. Bilge Keels on the Resolution. Tests of Different Paints for the Bottoms of Ships. Contracts for the Engines and Boilers of the Cæsar and Illustrious. Regulation in Regard to Telescopic Sights. Speed Trial of the English Torpedo-Boat Destroyer Lynx. The completion of the German Battleship Weissenburg. Launch of the Ram Piet Hein of the Dutch Navy. Launch of the Danish Protected Cruiser Heimdal. The United States Navy. Official Report of the Trial of the Minneapolis. Proposal to Alter the Whaleback Steamers into Auxiliary Cruisers. Plans for a New Torpedo-Boat. The Pneumatic Dynamite Gun. The Holland Submarine Boat. Speed Trial of the Argentine Cruiser Patria.

Attempt to Discover the Sunken Russian Monitor Rusalka. Russian Armor Tests. Russian Naval Budget for 1894. The River Steamer Hibernia. Life Buoy Illuminated by Electricity. Lightning and Compass Disturbances Observed on Board Ships.

No. 12. Essay on the Best Tactics to Develop the Efficiency of Ships and their Armaments (Gun, Ram and Torpedo) in a Battle between Fleets, Groups and Single Vessels. Progress in Ships' Armor and Armament during 1893. An Aluminium Torpedo-Boat. Harveyizing Heavy Armor Plates. The Danish Naval Budget, 1895–'96. The Bursting of the Air Chamber of a Whitehead Torpedo. Petroleum Bricks. The Organization of the Italian War Fleet. Continuation of the Work on the Panama Canal. A Modern Merchant Schooner. Temperature and Fire Indicator. The Armament of French Mail Steamers. Increase of the U. S. Navy. Torpedo-Boat Tests in the U. S. English Torpedo-Boat Destroyers. The Reconstruction of the English Battleship Monarch. The Signal Apparatus of Prince Louis of Battenberg and Captain Percy Scott. New Turkish War Vessels. Launch of the Italian Protected Cruiser Calabria, and of the French Cruiser Descartes. H. O.

REVUE DU CERCLE MILITAIRE.

SEPTEMBER 16 AND 30. Apropos of the Flying Machine. Fortress Manœuvres. Modes of Warfare Among the Moors: the Battle of Schoutelma. New Discipline Regulations in the Portuguese Army. Promotion of Supplementary Officers in the Italian Army.

OCTOBER 7. The War between China and Japan; The Battle of Yalu. Modes of Warfare Among the Moors; the Battle of Schoutelma (concluded). The New Discipline Regulations in the Portuguese Army (concluded).

OCTOBER 14. The Telemeters. Smokeless Powders. Infantry Fighting. The War between China and Japan; the Battle of Yalu.

OCTOBER 21. The Lombock Expedition (with map). The Academy of War in Berlin.

OCTOBER 28. Recruiting of Supplementary Officers in Italy. The Academy of War in Berlin (concluded). The Telemeters (continued).

NOVEMBER 4. Superior Military Instruction in Germany. The Telemeters (concluded). Recruiting of Supplementary Officers in Italy (concluded),

NOVEMBER 11. Infantry Tactics. A New Bill for the Recruiting of the Italian Army.

NOVEMBER 18. A Study by an English Officer of the "Lava" of the Cossacks. Infantry Staff in France and Spain. Infantry Tactics (continued).

REVUE MARITIME ET COLONIALE.

SEPTEMBER. Electricity in America. The Geometry of Diagrams. Influence of Sea Power on History, by Captain Mahan, U. S. N. History of the Adoption of the French Tri-color Flag.

OCTOBER. Sea Currents and their Origin. Graphic Ephemerides giving the Co-ordinates of Stars for use of Navigation. Influence of Sea Power, etc. A Note Relative to the Twinkling of Stars. Vocabulary of Powders and Explosives (continued).

NOVEMBER. Notes on a Phenomenon Observed During the Firing of Projectiles with High Initial Velocity. The Meteorologic Theories of M. Duponchel: a Critical Study. Electricity in America (ended). A Note on the Compasses of the Sea-going Torpedo-boat Orage.

RIVISTA DI ARTIGLIERIA E GENIO.

JULY AND AUGUST. Rifling in Modern Ordnance. Dynamo-Electric Engine (37 diagrams). About the Central School of Firing on the Nettuno.

SEPTEMBER. Horsemanship of Recruits in Field Batteries. Coast Fortifications. The Uniform of Field Artillerymen. On Geodetic Refraction.

OCTOBER. Indirect Firing by Infantry. Fortress Warfare. Foot Artillery Compared with the German.

RIVISTA MARITTIMA.

OCTOBER. (With Supplement). Water-Tube Boilers; Experiments with Screw Types, Modes of Conducting them, and of Applying the Results. Lubricating Oils.

NOVEMBER. (With Supplement). Historic Reasons that Brought About the Question of Corea. Electric Navigation and the War Navy. A Rapid Glance at the General Conditions of the Art of Navigation Among the Ancients.

SOCIÉTÉ DES INGÉNIEURS CIVILS.

AUGUST, 1894. Photography applied to Topography. New Altimetric Solutions by Means of the Hysometric Rules. An

Account of the Contest of Automobile Vehicles, Organized last July by Le Petit Journal: The Trip from Paris to Rouen. The Canet Gun.

"Only three systems are considered by the writer: the Krupp, the Armstrong, and the Canet. The first attempts of M. Canet date from 1887-1888. Three guns 48 calibers long, 10 cm., 12-cm. and 15-cm. caliber were built for the Paris Exhibition of 1889. From the start, it was decided that the working of the breech should necessitate one motion only, in order to simplify and render as automatic as possible the action of the gunner. After several trials, M. Canet decided in favor of a movement operated by a lever working in a horizontal plane. It took four years of persevering efforts and successive improvements to obtain the type now in use in the French Navy. The task of constructing the mount was little less difficult than the building of the gun itself. A full description (with plates) is given of both the Canet gun and its mount."

Laying out of Railroads: a Method of Drawing a Normal to a Junction Curve. The Anthracite of the Val d'Aoste. J. L.

STEAMSHIP.

VOLUME VI., No. 63, SEPTEMBER, 1894. The Modern Battleship as a Fighting Machine. The Ventilation of Steamships. New Foliated Rolled Metal Dynamo Brushes.

OCTOBER. The Decay and Failure of Tail Shafts in Steamers. The Preservation of Ships' Bottoms.

An apparatus consisting of a perforated tube following along the stem and keel, fed with oil from a tank on deck has been patented; its object is to reduce friction as well as to keep the ship's bottom clean.

The Mosher Patent Safety Water-Tube Boiler. New Combined Engine and Dynamo.

NOVEMBER. Improvements in Sails and Rigging for Sailing Vessels and Steamers. An Aluminum Torpedo-Boat.

TRANSACTIONS OF THE INSTITUTION OF NAVAL ARCHITECTS.

VOLUME XXXV., 1894. On Points of Interest in the Construction and Repair of Vessels Carrying Oil in Bulk. Fast Ocean Steamships. Some Experiments on the Combination of Induced Draught and Hot Air, Applied to Marine Boilers Fitted with "Serve" Tubes and Retarders. Wear and Tear in Ballast Tanks. An Account of some Experiments on the Transmission of Heat through Steel Plates, from Heated Gas at the One Side to Water at the Other. On the Present Position of Water-Tube Boilers as Applied for Marine Purposes. On the Theory of Thin Plating, and its Applicability to Calculations of the Strength of Bulkhead Plating and Similar Structures. Qualities and Performances of Recent First-Class Battleships. The Amplitude of Rolling on a Non-Synchronous

Wave. The Stresses on a Ship due to Rolling. Leclert's Theorem. Recent Experiments in Armor. The Detachable Ram, or the Submarine Gun as a Substitute for the Ram, by Captain W. H. Jaques. Leaves from a Laboratory Note Book. Circulation in the "Thornycroft" Water-Tube Boiler. On Water-Tube Boilers. On the Comparative Merits of Cylindrical and Water-Tube Boilers for Ocean Steamships. Further Investigations on the Vibrations of Steamers. On the Relation between Stress and Strain in the Structure of Vessels. On Ship-Shaped Stream Forms, by Naval Constructor D. W. Taylor, U. S. N. Steam Pressure Losses in Marine Engines. Some Experiments with Triple-Expansion Engines at Reduced Powers. On a Fluid Pressure Reversing Gear.

TRANSACTIONS OF THE NORTHEAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

VOLUME X., 1893–94. On a Method of Comparing Steamship Performances and Estimating Powers and Speeds of Ships. The Dangerous Working Heat of Mild Steel, and the Effect of Annealing and Air-Cooling. On Certain Principles of Motion as Taught by the Pendulum, and as Illustrated by the Resistance of Ships and other Boats Moving Through Fluids; together with a Brief Sketch of the Pendulum Speed Power Meter. Mercantile Marine Engineers. On a New System of Construction for Large Vessels of Cellular Type. Oil Engines. Bases for Classification of Vessels Proportioned to their Strength to Resist Bending and Vibration. Discussions.

UNITED SERVICE GAZETTE.

No. 3219, SEPTEMBER 15, 1894. The Eastern Question and the Defense of Constantinople, IV. The Training of Naval Officers.

SEPTEMBER 22. Further Experiments with the Boynton Shield. The Eastern Question, etc., V. China and Japan. Naval Engineering.

SEPTEMBER 29. Port Arthur. China and Japan. Some Lessons of the Naval Battle off the Yalu.

OCTOBER 6. An Aluminum Torpedo-Boat. Our Mediterranean Policy. Stations of the Royal Army, Navy and Marine Forces.

OCTOBER 13. The War in the East. The Warnings of History.

OCTOBER 20. Naval Progress at Home and Abroad.

OCTOBER 27. Gibraltar as a Naval Base. The Use of Captive Balloons at Sea. Naval Officers' Training.

NOVEMBER 3. Stations of the Royal Army, Navy and Marine Forces. First Aid to the Wounded. The Church and the Welfare of the Navy and Army. Warships and their Armaments.

NOVEMBER 10. The French Navy. Modern Cruisers. National Defense. J. H. G.

LE YACHT.

SEPTEMBER 15. Flag Officer's Commands: Modifications to be made in the Law concerning the General Staff.

SEPTEMBER 22. The Navy at Madagascar. Electricity Applied to Canal Boats.

SEPTEMBER 29. The Battle of Yalu. Launching of the Cruiser Descartes.

OCTOBER 6. The Battle of Yalu. Electricity: Electric Servo-Motor (Edm. Cahen). The Aluminum Torpedo-Boat, and Aluminum Industry in France.

OCTOBER 13. About the Battle of Yalu.

"In the absence of important factors that constitute the naval battle at Yalu, it would be presumptuous at this time to offer any lesson upon the engagement. But one point upon which most naval officers will agree is that if two European squadrons composed about the same as the Chinese and Japanese had fought for five consecutive hours, very little would have been left of them at the end of the action. This consideration must not be lost sight of in commenting upon the battle of Yalu. One Chinese vessel was rammed by a sister-ship. Fire found a ready prey in the wood-work. The Chinese firing was poor. The Japanese fire was superior, but still indifferent considering the enormous consumption of ammunition. Besides, the Japs manœuvred better and maintained good discipline. The battle demonstrated the importance of speed as a great factor, the use of R. F. cannon and tactical ability, but proves nothing in regard to resistance of armor, four heavy projectiles only having hit the Chinese.

OCTOBER 20. The Work of the Board of Inquiry. The Question of Yacht Measurement in England and America. The Torpedoing of the Aquidaban. An American Submarine Torpedo-Boat.

OCTOBER 27. The Battleship Brennus. Electricity: The working by Electricity of Armored Turrets; The Question of Yacht Measurement in England and the United States.

NOVEMBER 3. The Navy Estimates for 1895.

NOVEMBER 10. The War between China and Japan. Electricity: Electric Search-Lights.

NOVEMBER 17. The Naval Advisory Board and the Board of Inquiry. The Italian Navy: the Navy Estimates and the Dock Yards. A Naphtha Steam-Launch. J. L.

REVIEWERS AND TRANSLATORS.

Lieut. HUGO OSTERHAUS, U. S. Navy, Lieut. J. H. GLENNON, U. S. Navy,
" ALBERT GLEAVES, " " H. G. DRESEL, "
Prof. JULES LEROUX.

OFFICERS OF THE INSTITUTE,

1895.

Elected at the regular annual meeting, held at Annapolis, Md., October 12, 1894.

President.

REAR-ADMIRAL S. B. LUCE, U. S. N.

Vice-President.

COMMANDER A. S. SNOW,* U. S. N.

Secretary and Treasurer.

LIEUTENANT J. H. GLENNON, U. S. N.

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PROFESSOR N. M. TERRY, A. M., PH. D.
LIEUTENANT J. H. GLENNON, U. S. N. (*ex-officio*).

*Captain Philip H. Cooper, U. S. N., was elected Vice-President December 15, by the Board of Control, Commander Snow having resigned.

SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1896.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1896. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

7. The successful competitor will be made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

By direction of Board of Control.

J. H. GLENNON,
Lieut., U. S. N., Secretary and Treasurer.

ANNAPOLIS, MD., *January* 1, 1895.

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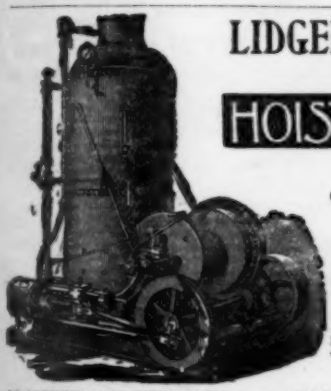

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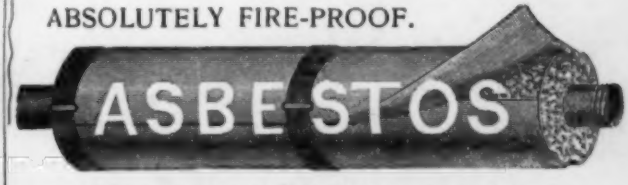

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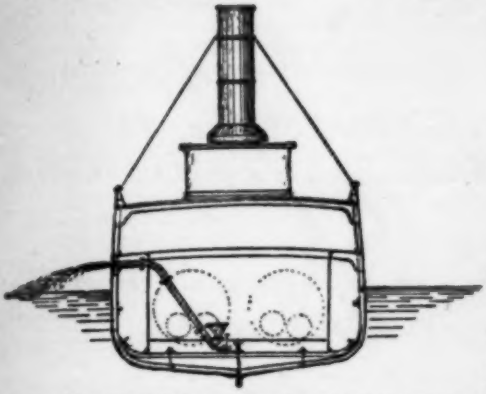

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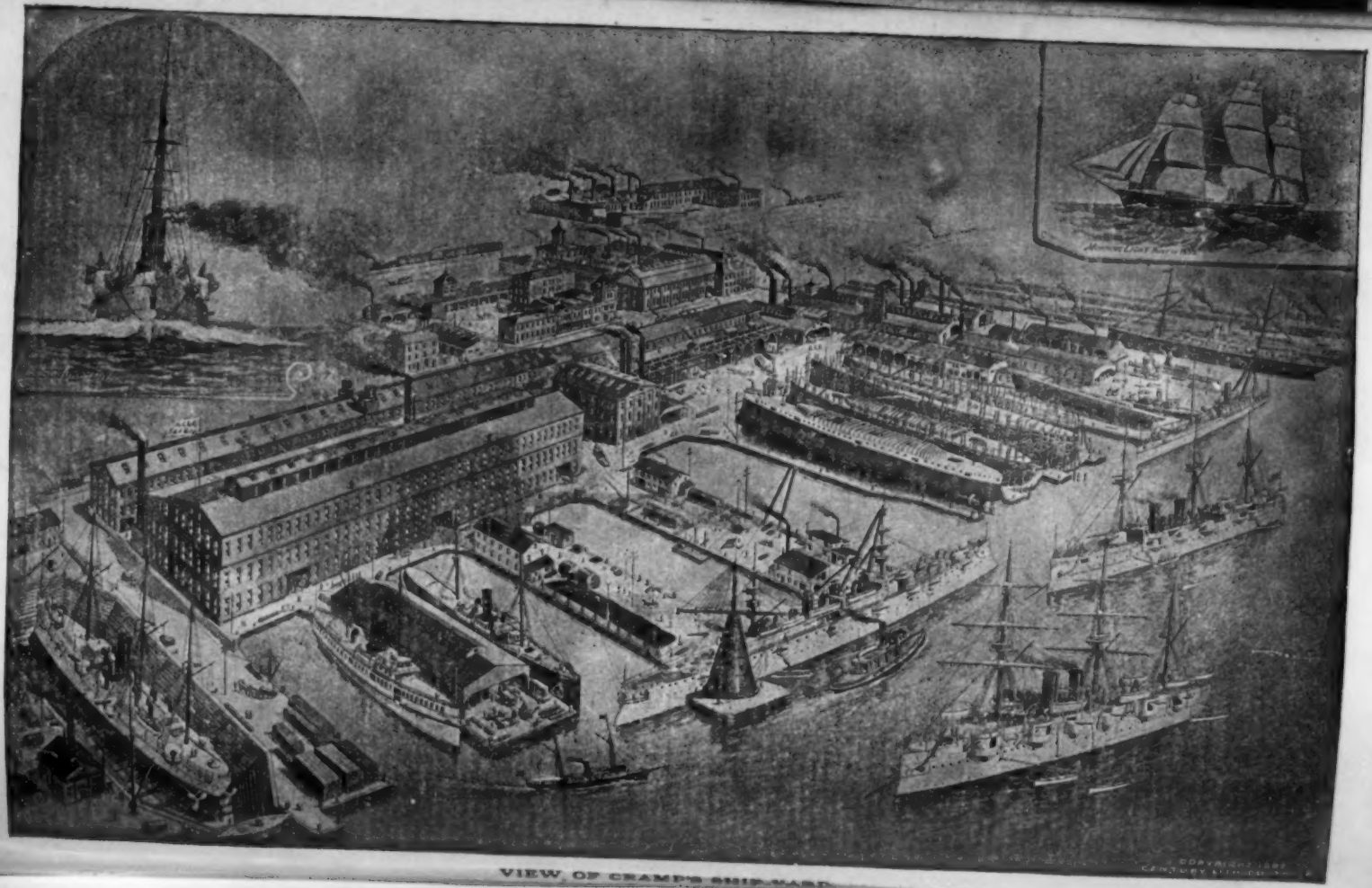

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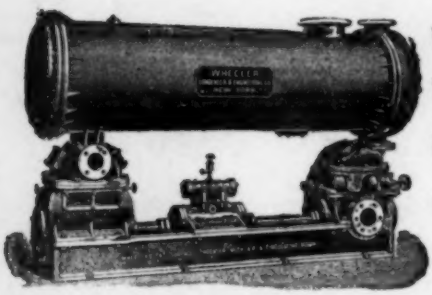

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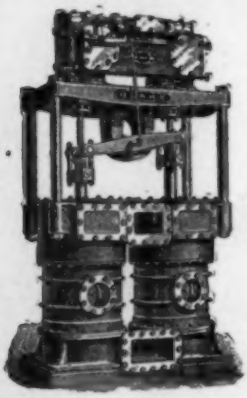

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Vol. XX., No. 4. 1894. Whole No. 72.

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OF THE

UNITED STATES

NAVAL INSTITUTE.

VOLUME XX.

PUBLISHED QUARTERLY BY THE INSTITUTE.

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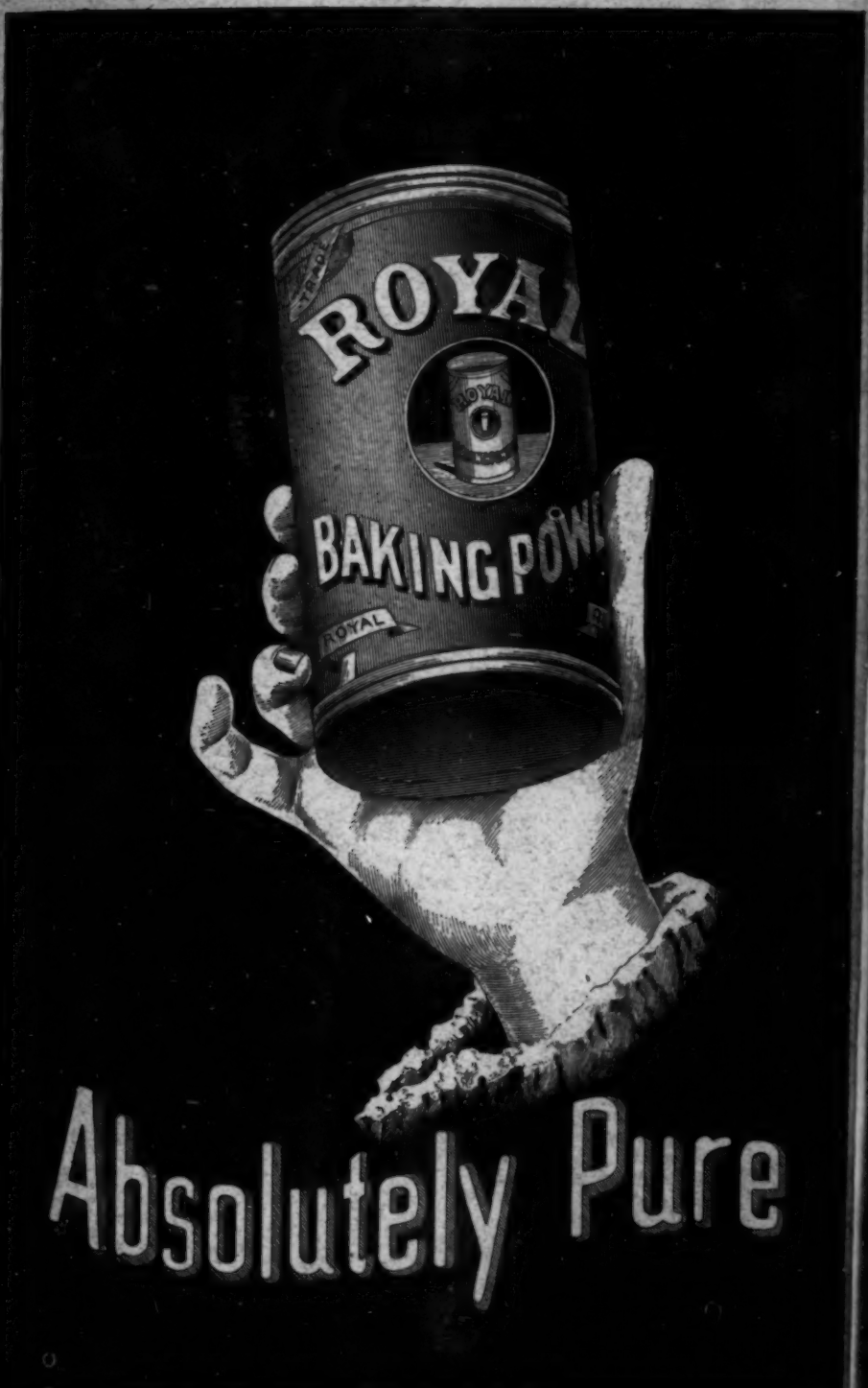
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NOTICE.

The U. S. Naval Institute was established in 1873, having for its object the advancement of professional and scientific knowledge in the Navy. It now enters upon its twenty-first year of existence, trusting as heretofore for its support to the officers and friends of the Navy. The members of the Board of Control cordially invite the co-operation and aid of their brother officers and others interested in the Navy, in furtherance of the aims of the Institute, by the contribution of papers and communications upon subjects of interest to the naval profession, as well as by personal support and influence.

On the subject of membership the Constitution reads as follows:

ARTICLE VII.

SEC. 1. The Institute shall consist of regular, life, honorary and associate members.

SEC. 2. Officers of the Navy, Marine Corps, and all civil officers attached to the Naval Service, shall be entitled to become regular or life members, without ballot, on payment of dues or fee to the Secretary and Treasurer, or to the Corresponding Secretary of a Branch. Members who resign from the Navy subsequent to joining the Institute will be regarded as belonging to the class described in this Section.

SEC. 3. The Prize Essayist of each year shall be a life member without payment of fee.

SEC. 4. Honorary members shall be selected from distinguished Naval and Military Officers, and from eminent men of learning in civil life. The Secretary of the Navy shall be, *ex officio*, an honorary member. Their number shall not exceed thirty (30). Nominations for honorary members must be favorably reported by the Board of Control, and a vote equal to one-half the number of regular and life members, given by proxy or presence, shall be cast, a majority electing.

SEC. 5. Associate members shall be elected from officers of the Army, Revenue Marine, foreign officers of the Naval and Military professions, and from persons in civil life who may be interested in the purposes of the Institute.

SEC. 6. Those entitled to become associate members may be elected life members, provided that the number not officially connected with the Navy and Marine Corps shall not at any time exceed one hundred (100).

SEC. 7. Associate members and life members, other than those entitled to regular membership, shall be elected as follows: Nominations shall be made in writing to the Secretary and Treasurer, with the name of the member making them, and such nominations shall be submitted to the Board of Control, and, if their report be favorable, the Secretary and Treasurer shall make known the result at the next meeting of the Institute, and a vote shall then be taken, a majority of votes cast by members present electing.

The Proceedings are published quarterly, and may be obtained by non-members upon application to the Secretary and Treasurer at Annapolis, Md. Inventors of articles connected with the naval profession will be afforded an opportunity of exhibiting and explaining their inventions. A description of such inventions as may be deemed, by the Board of Control, of use to the service, will be published in the Proceedings.

Single copies of the Proceedings, $1.00. Back numbers and complete sets can be obtained by applying to the Secretary and Treasurer, Annapolis, Md.

Annual subscription for non-members, $3.50. Annual dues for members and associate members, $3.00. Life membership fee, $30.00.

All letters should be addressed to Secretary and Treasurer, U. S. Naval Institute, Annapolis, Md., and all checks, drafts and money orders should be made payable to his order, without using the name of that officer.